Science Library

Vol. 69 JUNE, 1942 No. 6

145

Bulletin

JUN 5 1942

of the

Torrey Botanical Club

Editor
Harold W. Rickett

Associate Editors
Irving W. Bailey — Henry Allan Gleason
Edward W. Berry — Arthur H. Graves
Stanley A. Cain — John W. Shive
M. A. Chrysler — R. P. Wodehouse
Michael Levine

CONTENTS

Disintegration of Ovules in Tetraploid-Diploid and in Incompatible Species Crosses in Datura.
Eva R. Sansome, S. Satina and A. F. Blakeslee 405

Thiamine in Some Common American Trees.
P. R. Burkholder and A. G. Snow, Jr. 421

An Isolated Colony of Plants on a Glacier-Clad Mountain.
William S. Cooper 429

A New Tetraploid Wheatgrass from Nevada.
Joseph H. Robertson and Lloyd Weaver 434

A New Genus of Rubiaceae from Mexico ..... *Maximino Martínez* 438

A New Genus of the Anacardiaceae from Colombia ..... *Fred A. Barkley* 442

New and Critical Euphorbiaceae Chiefly from the Southeastern United States ..... *Leon Croizat* 445

Asa Gray's Earliest Botanical Publications (1833–1836).
H. W. Rickett and C. L. Gilly 461

Index to American Botanical Literature 471

Published for the Club monthly except
July, August and September
by
THE SCIENCE PRESS PRINTING COMPANY
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PENNSYLVANIA

THE TORREY BOTANICAL CLUB

Officers for 1942

President: C. STUART GAGER

Vice-presidents: JOHN A. SMALL, CLYDE CHANDLER

Recording Secretary: HONOR M. HOLLINGHURST

Corresponding Secretary: HAROLD C. BOLD

Treasurer: W. G. WHALEY

Editor: HAROLD W. RICKETT

Business Manager: MICHAEL LEVINE

Bibliographer: MRS. LAZELLA SCHWARTEN

For information about the publications and proceedings of the Club, and about membership, dues, and meetings, see **Torreya**, published bimonthly by the Club.

The Bulletin of the Torrey Botanical Club

Subscriptions, dues, and inquiries about back numbers should be sent to the office of publication, N. Queen St. and McGovern Ave., Lancaster, Pa., or to Dr. W. G. Whaley, Department of Botany, Barnard College, New York, N. Y. Correspondence about advertisements and circulation should be addressed to Dr. Michael Levine, Montefiore Hospital, New York, N. Y. Communications about exchanges should be sent to Dr. Harold C. Bold, Department of Botany, Barnard College, New York, N. Y. Manuscripts intended for the Bulletin should be sent to Dr. H. W. Rickett, The New York Botanical Garden, Bronx Park (Fordham Branch P. O.), New York, N. Y.

Claims for missing numbers must be made within 60 days from the date of issue.

The subscription price of the Bulletin of the Torrey Botanical Club is $6.00 a year except to active members of the Club. Of the annual membership dues, $3.00 covers a year's subscription to the Bulletin.

Torreya. Bimonthly; established 1901. Of the annual dues $0.50 is for a year's subscription to Torreya; price to non-members, $1.00. Manuscripts intended for publication in Torreya should be addressed to Dr. W. J. Bonisteel, Department of Biology, Fordham University, New York, N. Y.

Entered as second-class matter October 8, 1940 at the post office at Lancaster, Pa., under the Act of March 3, 1879. Accepted for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, section 538, P. L. & R.

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 405–420 JUNE, 1942

DISINTEGRATION OF OVULES IN TETRAPLOID-DIPLOID AND IN INCOMPATIBLE SPECIES CROSSES IN DATURA[1]

EVA R. SANSOME, S. SATINA AND A. F. BLAKESLEE

INTRODUCTION

Since tetraploids were first obtained in *Datura stramonium* (1), a great many crosses between tetraploids and diploids have been attempted. This was found to be an extremely sterile combination. When the diploid is used as the female parent, viable seeds are practically never obtained because diploid pollen tubes usually burst in a diploid style (5). Only once out of many attempts have we reliable evidence that a viable seed came from the cross $2n \times 4n$. This gave rise to a $3n$ seedling.

When the tetraploid is used as female, a few seeds are obtained, of which fewer germinate. Our records show that from 1922 to date, 103 offspring were obtained from many $4n \times 2n$ crosses. Of these, 35 plants were diploid, 57 triploid, and 11 tetraploid. In our present tests tetraploids selfed produced from 95 to 117 seeds per capsule.

The present investigation was undertaken primarily to discover if possible the nature of the incompatibility of the tetraploid-diploid cross.

MATERIAL AND METHODS

For detailed study, four plants, which had been determined by Dr. Bergner to be tetraploids with quadrivalents in all 12 sets, were crossed with diploids which belonged to the same standard Line 1.

The behavior of haploid pollen tubes in a tetraploid style was studied by means of acetocarmine smears and compared with the behavior of diploid pollen tubes in the tetraploid style. The contents of ripe ovaries were recorded as well as of ovaries from 6 to 14 days old. Finally capsules from 1 to 10 days after pollination were fixed in formaldehyde-acetic-alcohol solution. Sections 12 μ to 16 μ thick were stained with Heidenhain's iron alum haematoxylin, or by the Feulgen method. Haematoxylin gave a clearer anatomical picture. The Feulgen method was good for the details of fertilization and for chromosome counts.

OBSERVATIONS

Incompatibility of the $4n \times 2n$ Cross. To discover the fertility of the $4n \times 2n$ cross relative to the control $4n \times 4n$, the contents of a number of ripe capsules were analyzed. Five ripe $4n \times 2n$ capsules contained 31 large

[1] This investigation has been supported in part by a grant from the Carnegie Corporation to the Carnegie Institution of Washington.

[The BULLETIN for May (69: 331–404) was issued May 1, 1942]

black seeds (1.0 per cent), 16 small empty black seeds (0.5 per cent), 1927 relatively large aborted ovules (63.8 per cent), and 1045 very small aborted ovules (34.6 per cent). Three ripe $4n \times 4n$ capsules contained 328 large seeds (25.9 per cent), 8 small black empty seeds (0.6 per cent), 44 relatively large aborted ovules (3.5 per cent), and 887 very small aborted ovules (70.0 per cent).

Also, young capsules 7 to 14 days after pollination were dissected in 80 per cent alcohol and their contents recorded. Three classes were distinguished at this early stage and it was possible to get an estimate of the total ovule content as shown in table 1. In both the 5 controls ($4n \times 4n$) and in the 5 incompatible crosses ($4n \times 2n$) the number of ovules averaged about 450. The percentage of medium-sized ovules in the young capsules (66.45 per cent) is close to that of the small black seed class plus the larger aborted ovules in the ripe capsules (64.36 per cent). These classes probably consist of fertilized ovules which stopped development at various stages.

TABLE 1

Dissected capsules, 7–14 days after pollination
(Percentages in parentheses)

Cross	No. of capsules	Total ovules	Large ovules	Medium ovules	Small ovules
4n × 4n	5	2103	1158 (55.1)	121 (5.8)	824 (39.2)
4n × 2n	5	2432	13 (0.5)	1616 (66.5)	803 (33.0)

There was a considerable variation in the number of ovules in a capsule. For 21 capsules there was an average of 537 ovules. They ranged from 340 to 851, dependent upon the vigor of growth.

There is always a sharp distinction between the contents of a crossed and of a selfed capsule as shown by the number of large seeds. This is evident from examination of seed collections from former years in which the smaller aborted ovules were generally discarded. Thirty-three capsules from the cross $4n \times 2n$ had an average of 5.1 large seeds, the range being from 0 to 19. Eighteen selfed capsules had an average of 107.6 large seeds per capsule with a range from 31 to 264. The difference between the fertility of the self and the cross is thus very striking. Actually the difference in fertility is even greater than these results indicate since many of the large seeds from the crossed capsules do not germinate and some are found to be empty when dissected.

As previously stated there is a considerable variation in the contents of the ripe capsule and the question arises whether the number of large seeds can be correlated in any way with the numbers of the other classes in the crossed capsules. No positive correlation could be found between the number

of large and the number of small seeds. Thus a capsule with 172 small black seeds had 6 large seeds but a capsule with only 1 small black seed had 7 large seeds. Ten large capsules had an average of 6.3 large seeds and 65.7 small seeds. This average number of large seed is only slightly higher than the average for all capsules (5.1). The number of large seeds per capsule is relatively stable but the number of small black seeds varies considerably according to environmental conditions.

Effect of Early Pollination. Preliminary tests were made on the effects of pollinating young flowers. A number of $4n$ flowers were pollinated with n pollen from the diploid when the corolla was just visible above the calyx. Many of these did not set, but 7 small capsules were obtained which gave an average of 1.9 large seeds per capsule. Most of these capsules contained a greater number than usual of the very small failures that are presumed to result from unfertilized ovules.

Pollination in the young condition therefore did not increase the number of large seeds.

Effect of Treatment with Naphthaleneacetic Acid. It has been shown that naphthaleneacetic acid injected into *Datura* capsules stimulates the growth of unfertilized ovules (13). It was thought, therefore that this substance might stimulate the further development of the embryo and endosperm if fertilization occurs in this cross. Accordingly capsules were injected with naphthaleneacetic acid from 3 to 7 days after pollination. The results from 5 good ripe capsules are shown in table 2. It is clear that while the number of small black empty seeds is increased by the treatment (64.8 untreated: 278.8 treated) the number of large seeds is not much affected (6.2: 7.2).

TABLE 2

Average number of large seeds and small black seeds from ripe capsules showing good "setting"

Type	No. of capsules	Av. large seed per caps.	Av. small black seeds per caps.
4n × 2n untreated	11	6.2	64.8
4n × 2n treated with N.A.A.	5	7.2	278.8

Pollen Tube Behavior. Pollen-tube behavior was studied with the dissection method described by Buchholz (4). Acetocarmine smears were made of the styles of $4n$ flowers self-pollinated and pollinated with n pollen. Generally two nuclei could be distinguished in the pollen tube but it was often very difficult to determine whether these nuclei were the two male gametes, or whether in some tubes one nucleus was the vegetative nucleus and

the other the undivided generative nucleus. The vegetative nucleus is diffuse and lightly stained and may be missed. Fortunately, pollen tubes containing the generative nucleus in division were obtained in both the cross and control. In the $4n$ selfed case the generative nucleus had 24 chromosomes as expected and the division occurred about 16 hours after pollination (fig. 2). In the $4n \times 2n$ cross the generative nucleus had 12 chromosomes and the division occurred about 17 hours after pollination (fig. 1). The present observations

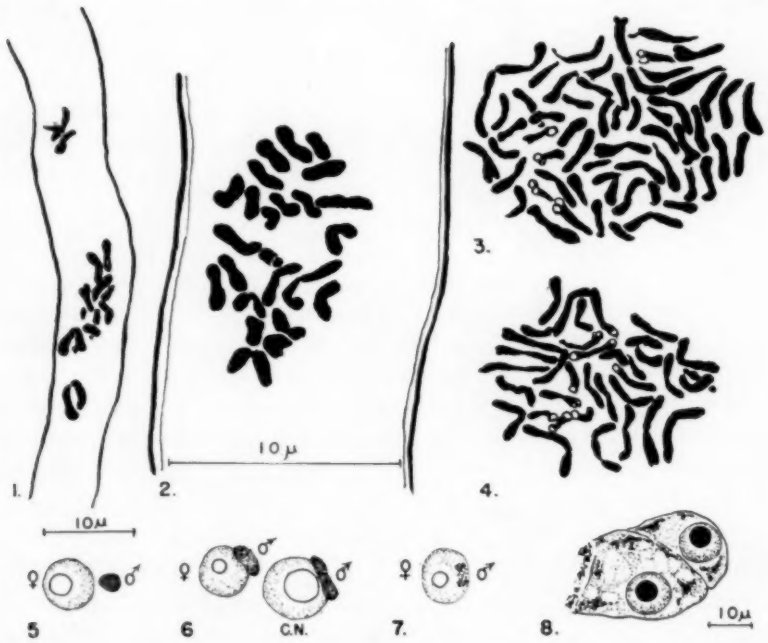


FIG. 1. Division of generative nucleus in $1n$ pollen tube, showing 12 chromosomes. FIG. 2. Division of generative nucleus in $2n$ pollen tube, showing 24 chromosomes. FIG. 3. Endosperm cell with 60 chromosomes in metaphase, 4 days after pollination. FIG. 4. Zygote with 36 chromosomes in metaphase, 4 days after pollination. FIG. 5. Male gamete approaching egg, 48 hours after pollination. FIG. 6. Double fertilization, male gametes in contact with egg and central nuclei, 48 hours after pollination. FIG. 7. Fusion of egg nucleus and male gamete almost completed, 48 hours after fertilization. FIG. 8. Young proembryo, 6 days after pollination. All drawings with the exception of figure 2, which was from a $4n \times 4n$ cross, were from $4n \times 2n$ crosses. *c.n.*, central nucleus; ♂, male gamete; ♀, egg nucleus.

show that the division of the generative nucleus of the haploid pollen growing in a tetraploid style is normal. Hence the sterility of the cross is not due to any abnormal behavior of the male gametophyte.

Fertilization in the $4n \times 2n$ Cross. The next step was to see whether pollen tubes enter the ovule and whether fertilization occurs. Since the

pollen tubes contain a dense cytoplasm which is easily distinguished, the question of whether or not the haploid pollen tubes enter the ovules of the tetraploid is readily settled by an examination of sectioned capsules (fig. 9). Actually the haploid pollen tubes enter the ovules freely. Of 54 capsules from the $4n \times 2n$ cross only three showed no signs of pollination.

At the time of entry of the pollen tube the embryo-sac contains the two synergids, the egg, and the central nucleus, and sometimes the remains of the three antipodal cells. The embryo-sac is surrounded by a well marked single layer of cells, the endothelium (figs. 9, 14, 15). The endothelium is interrupted at the chalazal end of the embryo-sac where it opens into the chalazal pocket (fig. 10). The pollen tube carries into the embryo-sac the two male gametes which are deeply stained and much smaller than the egg and central nucleus. The difference in size between the male and female gametes is intensified in this cross because the egg cell is diploid and the central nucleus tetraploid, while the male gamete is haploid. Sections with various stages in fertilization were frequent. Figure 5 shows a male gamete approaching the egg and figure 6 shows a male gamete in contact with the egg and another in contact with the central nucleus within the same embryo-sac. A fusion nucleus made up of egg and male gamete is shown in figure 7. Generally the central nucleus is fertilized first and in many cases the egg nucleus can be seen with a deeply staining region, representing the male nucleus which has fused with it at a time when the endosperm nucleus has already undergone division.

The pollen-tube cytoplasm can sometimes be seen to contain one or two bodies staining deeply with the Feulgen method after the egg and central nucleus appear to have been fertilized. These bodies, the so-called X-bodies, are usually considered to be disintegrating nuclei, the tube nucleus and the nucleus of the synergid through which the pollen tube grew. The deeply staining character of the tube and of the synergid nuclei as contrasted with their earlier faintly staining character may be related to the process of disintegration.

Post-Fertilization Behavior. After fertilization the endosperm nucleus divides several times before the division of the zygote. When the endosperm cells are from about 30 to 40 in number, they may begin to disintegrate, but disintegration usually begins later. Figure 10 shows a much advanced stage of disintegration. The large majority of proembryos reach the 2–4- or rarely the 6-celled stage and then degenerate. A 2-celled proembryo is seen in figure 8. Accompanying the degeneration the endothelial cells enlarge and may divide periclinally so that the endothelium may become multilayered as shown in the micropylar end in figure 12. Often the outgrowths from the endothelium entirely fill up the embryo-sac. This behavior resembles that observed in unfertilized ovules treated with naphthaleneacetic acid (13).

Frequently the cells of the endothelium enlarge without division and then degenerate (fig. 13).

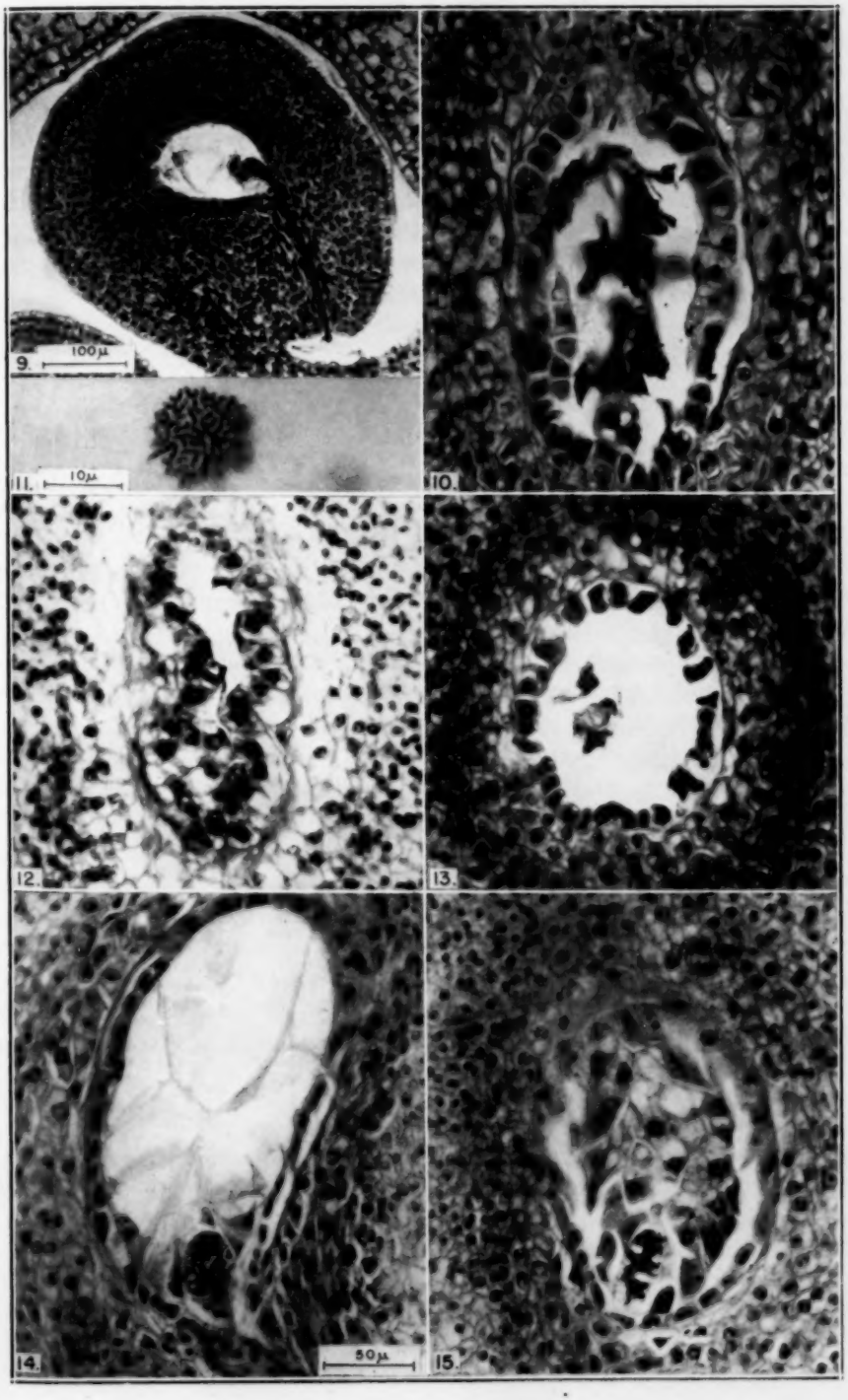
In order to obtain an idea of the number of ovules showing endosperm and embryo development, 288 ovules of a capsule fixed 6 days after pollination were recorded for embryo-sac contents. Of these, 201 ovules (70 per cent) had a proembryo and endosperm, 10 (3.5 per cent) had zygote (or egg cell) and endosperm, 2 had a proembryo only, 3 had endosperm only, 14 (4.9 per cent) were apparently unfertilized and in 55 (19.1 per cent) ovules the contents were too far disintegrated to be analyzable. Consequently, in at least 70 per cent of the ovules the egg and central nucleus undergo further development. This taken in conjunction with the observation of male and female gametes in close juxtaposition would seem to indicate that most of the ovules are actually fertilized, that is, the male nuclei fuse with the female nuclei. However, the possibility remained that the entrance of the male gametes stimulated the egg and central nucleus to divide without an actual fusion of nuclei. As mentioned in the introduction, the offspring of $4n \times 2n$ crosses included diploids, triploids, and tetraploids. On such a supposition the occasional diploid offspring would be due to the functioning of unfertilized eggs, the rare triploids would result from those ovules in which both egg and central nucleus had been effectively fertilized and tetraploids might result from the functioning of diploid pollen grains in cases in which accidental selfing could be eliminated. The small aborted ovules might then result from the failure of fertilization of the egg or of the central nucleus or both. This hypothesis was tested by counting the chromosomes in the endosperm and proembryo and has been shown to be untenable.

Nineteen endosperm nuclei, each from a different ovule, were found to have the $5n$ number of 60 chromosomes (figs. 3, 11) and one had 48 chromosomes ($4n$). Since more than 70 per cent of the ovules show endosperm development, and of these 19 out of 20 had endosperm with the $5n$ chromosome number, most of the ovules which fail must have had the central nucleus fertilized. The endosperm with $4n$ chromosomes presumably developed parthenogenetically.

The chromosome-number check on fertilization proved more difficult in the case of the proembryo, since the zygote usually divides only once or twice

Explanation of figures 9–15

FIG. 9. Pollen tube entering embryo-sac, 3 days after fertilization. FIG. 10. Embryo-sac with degenerated contents. Endothelium cells enlarged. Chalazal opening clearly shown. FIG. 11. Metaphase in $5n$ endosperm cell. FIG. 12. Ingrowing cells of endothelium, at micropylar end of embryo-sac. FIG. 13. Degenerating endothelium cells and embryo-sac contents. FIG. 14. Embryo-sac with 6–8 celled proembryo, few large endosperm cells and normal-appearing endothelium. FIG. 15. Embryo-sac with 6–8 celled proembryo, small compact endosperm cells and normal-appearing endothelium. Ovules in figures 10–15 were fixed 6 days after pollination. Figures 9–13 were from $4n \times 2n$ crosses, figures 14–15 from $2n \times 4n$ cross.


9.
100μ
11.
10μ
10.
12.
13.
14.
50μ
15.

before degenerating. Sections from 42 capsules involving thousands of ovules were examined. Four embryo divisions which could be counted with a fair degree of accuracy were triploid, one division was estimated to be approximately triploid and a sixth appeared to be diploid. In one of the embryo-sacs both endosperm and proembryo divisions were obtained (figs. 3, 4). These had 60 ($5n$) and 36 ($3n$) chromosomes respectively and must therefore have resulted from double fertilization. Hence fertilization in the $4n \times 2n$ cross must be the rule rather than the exception and the breakdown of the young ovules is not due to any observable irregularity in the fertilization process but must be due to some other cause or causes.

The $2n \times 4n$ Cross. As has already been shown, it is practically impossible to secure seeds from the cross $2n \times 4n$ on account of the bursting of most of the $2n$ pollen tubes in their growth through the $2n$ style (5). Since the stylar tissue through which the pollen tubes grow is developed from the epidermal or L-1 layer (2), $2n$ pollen tubes can be induced to grow through the style in a periclinal $4n$, $2n$, $2n$ chimera in which the L-1 layer is $4n$. Thus by using such periclinal chimeras as the female parents, the pollination $2n \times 4n$ has resulted in good pollen-tube growth and formation of capsules and seeds. The $2n \times 4n$ cross was not studied in as great detail as the $4n \times 2n$ cross.

Fertilization stages were not observed but the majority of ovules formed endosperm and proembryos after the entrance of the pollen tube. Endosperm nuclei with good metaphase plates were not observed but in two embryo-sacs the endosperm appeared to have approximately the tetraploid number. Hence in these cases at least fertilization of the central nucleus must have occurred.

The division of the endosperm nuclei proceeds to a certain stage as in the reciprocal cross and then disintegration occurs. Possibly the proembryo may be able to develop a little further in the $2n \times 4n$ cross since 8-celled proembryos were occasionally obtained. While the contents of the embryo-sac are degenerating, the endothelium cells may enlarge and divide to fill up the embryo-sac or may degenerate along with its contents. The behavior therefore seems to be essentially the same as in the $4n \times 2n$ cross, so far as the early stages are concerned.

The $4n \times 4n$ combination. The tetraploid shows a high percentage of quadrivalent formation and hence unbalanced gametes might be expected to occur occasionally as the result of non-disjunction or irregular distribution of univalents. Some observations were made to determine the degree of sterility which might result from such behavior.

Ovules from capsules fixed prior to fertilization were examined to see if any megaspore abortion occurs. From 250 ovules, 14 could not be scored

for technical reasons, the remainder had normal-appearing embryo-sacs. Megaspore abortion is therefore not frequent. An estimate of zygotic sterility due presumably to the functioning of unbalanced gametes was made on slides of four capsules fixed from 5 to 7 days after pollination, in which development had proceeded beyond the 2–4-celled stage in the non-degenerating ovules. The ratios of normal to degenerating embryo-sacs in these capsules were 12 : 5, 20 : 10, 37 : 20, and 52 : 19, making a total of 121 : 54. A number of apparently unfertilized embryo-sacs were observed but they were not recorded. It is probable that some unfertilized ovules were included in the degenerating class at this late stage in development. The results indicate that at least two-thirds of the fertilized ovules develop past the stage at which breakdown occurs in the $4n \times 2n$ and $2n \times 4n$ crosses. The decreased fertility of the tetraploid as compared with the diploid is due in part to the decreased efficiency of the $2n$ pollen, which leads to a failure of pollination in many ovules, and in part to zygotic abortion which probably results from chromosomal unbalance brought about by non-disjunction.

Comparison between $4n \times 4n$, $4n \times 2n$, and $2n \times 4n$ Crosses. It has been shown that fertilization occurs with a high frequency in the $4n \times 2n$ cross but that, whereas more than two thirds of the fertilized ovules in a $4n \times 4n$ capsule proceed to further development, only a very small proportion of the ovules in the $4n \times 2n$ capsule go further than the 4-celled proembryo stage, when degeneration usually occurs. It was thought that a different balance of growth rates between embryo and endosperm might be a factor and therefore it seemed desirable to compare the relative rates of endosperm and embryo division in the $4n \times 4n$ control and in the $4n \times 2n$ and $2n \times 4n$ crosses. The results of the observations are summarized in table 3. There is no sig-

TABLE 3

Average number of cells in endosperm for different stages in zygote
(Range in cell numbers given in parentheses)

Type of cross	No. ovules	Zygote before division	No. ovules	Zygote first division	No. ovules	Proembryo 2–6 cells
$4n \times 4n$	5	15.2 (12–16)	...	.....	3	121.0 (107–140)
$4n \times 2n$	5	15.2 (12–20)	5	35.2 (32–40)	9	51.0 (32–80)
$2n \times 4n$	2	20.0 (14–26)	...	.....	8	47.5 (32–66)

nificant difference in the rate of endosperm development before the division of the zygote in the $4n \times 4n$, $4n \times 2n$, and $2n \times 4n$ crosses. The average number of cells in the endosperm is from about 15 to 20. This indicates that at

least four divisions of the endosperm cells occur before the zygote divides. In ovules with 2–6-celled proembryos the number of endosperm cells in the $4n \times 4n$ cross becomes considerably greater than in $4n \times 2n$ and reciprocal crosses. It would be desirable to have more observations especially of the self. Despite the inadequacy of the data for biometrical treatment, it seems clear that in the incompatible crosses there is a definite slowing up in rate of division in the endosperm in comparison with that in the controls. In the $2n \times 4n$ cross an ovule was observed in which a 6–8-celled proembryo was accompanied by about 370 endosperm nuclei. That particular ovule could be distinguished from others in the same capsule by its numerous endosperm cells which were tightly packed and filled with cytoplasms (fig. 15). It would probably have produced one of the occasional seeds resulting from this cross. Figure 14 shows a more typical embryo-sac from the same slide which had a proembryo of similar size but only about 40 endosperm nuclei altogether. In this latter section the nuclei of most of the endosperm cells are not visible since they were at another level.

The Degeneration Process. When the proembryo is from 4- to 6-celled and the endosperm from about 50- to 80-celled, disintegration of the contents of the embryo-sac begins. This may occur from 4 to 6 days after pollination. Disintegration must proceed very rapidly, since ovules showing disintegration of only part of the contents of the embryo sac are rarely found. As a result of observations of a great number of ovules, 23 were found in which the disintegration process had clearly begun in the endosperm while the proembryo appeared intact. Apparently disintegration usually begins in the endosperm but the endosperm has more cells than the proembryo and perhaps for this or other reasons their disintegration is more obvious.

Accompanying the disintegration of the embryo-sac contents, and sometimes preceding the first visible signs of breakdown, an enlargement of the endothelium cells take place. These cells divide actively in a plane tangential to the embryo-sac as well as radially, so that the endothelium becomes multilayered and sometimes entirely fills up the embryo-sac (fig. 12). Sometimes, however, the endothelial cells disintegrate at the same time as or soon after the embryo-sac contents (fig. 13). It should be emphasized that the chalazal opening is always present regardless of the condition of the embryo-sac content (fig. 10).

Ratio of Chromosomal Numbers. For the diploid selfed, the chromosome numbers in the embryo, endosperm, and maternal tissue are respectively $2n$, $3n$, and $2n$, but for the tetraploid selfed the corresponding numbers are $4n$, $6n$, and $4n$. In the $4n \times 2n$ cross the figures are $3n$, $5n$, and $4n$, and in the $2n \times 4n$ cross they are $3n$, $4n$, and $2n$. The ratio of embryo to endosperm is 0.67 in the viable combinations $2n \times 2n$ and $4n \times 4n$ (Table 4). This ratio is

TABLE 4

Chromosomal ratios between tissues of different types of ovules in Datura stramonium

	$\frac{\text{Embryo}}{\text{Endosperm}}$	$\frac{\text{Embryo}}{\text{♀ tissue}}$	$\frac{\text{Endosperm}}{\text{♀ tissue}}$
Viable combinations			
$2n \times 2n$	$\frac{2n}{3n} = 0.67$	$\frac{2n}{2n} = 1.00$	$\frac{3n}{2n} = 1.50$
$4n \times 4n$	$\frac{4n}{6n} = 0.67$	$\frac{4n}{4n} = 1.00$	$\frac{6n}{4n} = 1.50$
Mostly nonviable combinations			
$4n \times 2n$	$\frac{3n}{5n} = 0.60$ (−)	$\frac{3n}{4n} = 0.75$ (−)	$\frac{5n}{4n} = 1.25$ (−)
$2n \times 4n$	$\frac{3n}{4n} = 0.75$ (+)	$\frac{3n}{2n} = 1.50$ (+)	$\frac{4n}{2n} = 2.00$ (+)

lower in the $4n \times 2n$ cross (0.60) and higher in the $2n \times 4n$ cross (0.75) than in the viable combinations. Similarly the ratios between maternal tissue and either embryo or endosperm in the viable combinations $2n \times 2n$ and $4n \times 4n$ are intermediate between those in the $4n \times 2n$ and reciprocal crosses.[2]

It will be noted that the ratios in both the compatible crosses ($2n \times 2n$ and $4n \times 4n$) are the same. It may be that any deviation from these ratios may bring about sterility despite the fact that in the reciprocal crosses, $4n \times 2n$ and $2n \times 4n$, ratios deviate in opposite directions from the compatible combinations. It has already been shown that there are several stages in the chemical regulation of embryo development (13). Too little is known at present, however, to warrant any suggestion as to how an alteration in chromosome numbers in the three tissues under discussion might adversely affect the physiology of the developing embryo.

Types of Offsprings. These reciprocal crosses agree in the greatly reduced number of viable seeds in comparison with the compatible combinations. The proportion of the different chromosomal types in the offspring needs some comment. The $4n \times 2n$ crosses resulted in 35 diploids, 57 triploids and 11 tetraploids. The $2n \times 4n$ cross gave 8 diploids, no triploids and 3 tetraploids. The numbers in the latter cross are inadequate and the absence of triploids therefore may not be significant. The origin of the tetraploids is not clear in the $4n \times 2n$ cross. They might be attributed to accidental selfing as

[2] The reciprocal cross $2n \times 4n$, it will be remembered, was secured from a $4n$, $2n$, $2n$ chimera in which a considerable number of $4n$ cells must be included in the term "maternal tissue." A study of ovular development in such chimeras which is under way would seem to show that the conductive tissue through which nutrients are brought to the embryo-sac is derived from the L–3 layer which is $2n$ in the periclinal chimera used in the above cross.

well as to a union of a reduced egg with an unreduced sperm cell. In the reciprocal cross, however, such an explanation would not be tenable. The $2n$ offspring from the $4n \times 2n$ cross are probably due to parthenogenesis of $2n$ egg cells. This explanation is given support by the fact that in all the 6 cases in which a $4n$ recessive female was crossed with a $2n$ dominant, the $2n$ offspring were recessive. A further investigation of the $2n \times 4n$ cross is being undertaken.

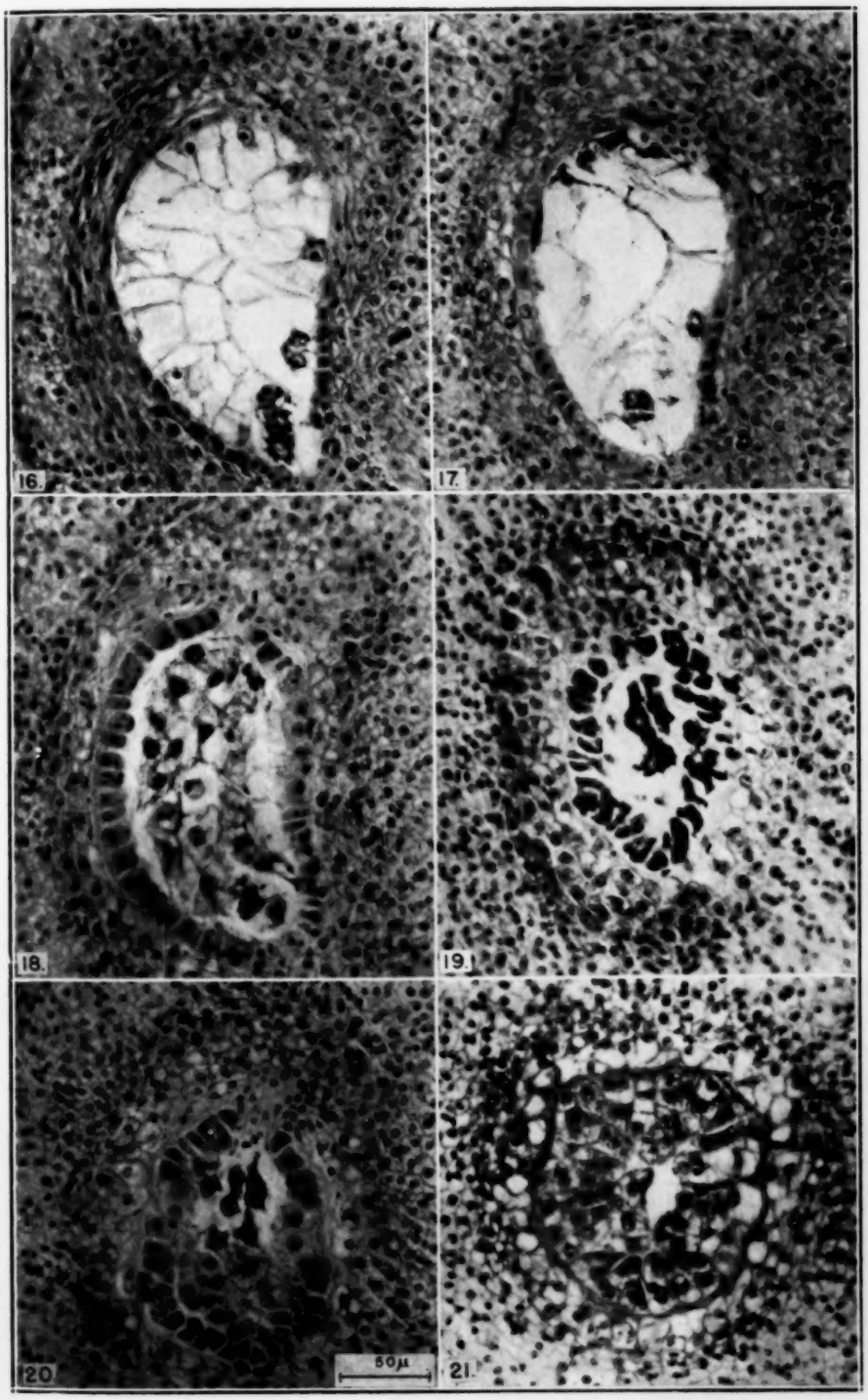
Studies by other investigators are of interest in this connection. Ledingham (9) in crosses between *Medicago falcata* ($n = 8$) and *M. sativa* ($n = 16$) obtained a few tetraploids but no triploids. In this case the tetraploids probably were the result of fertilization of unreduced female gametes which are occasionally produced. Two triploids were secured from a large number of reciprocal pollinations. The case cited has to do with a species cross and is therefore not entirely comparable with the crosses we are discussing in *Datura stramonium*. Dermen, however, has given the results of crosses between $2n$ and $4n$ individuals of the same species, Petunia (8). He secured $3n$ offspring from both the $4n \times 2n$ and from the reciprocal cross. Recently triploids were also obtained among other offspring by Randall in reciprocal crosses between four varieties of the vinifera grape and their autotetraploid forms (11). In *Allium* (10) and *Primula* (7) the $2n \times 4n$ cross failed entirely and triploids were secured only when the tetraploid was the female parent.

Incompatible Species Crosses. It has been shown that in spite of the fact that growth of pollen tubes and fertilization occur with a high degree of regularity in the *Datura stramonium* crosses, $4n \times 2n$ and $2n \times 4n$ (the latter by use of periclinal chimeras), only very few mature seeds result from these crosses. The causes for the degeneration of proembryo and endosperm at early stages remain unknown. The failure of the fertilized ovule to develop further in crossses within the same species may have a broader significance if the observations just discussed are compared with those made in incompatible species crosses.

It has been shown earlier in *D. stramonium* × *D. metel* crosses (12) that the inability to obtain viable seeds from certain species crosses in *Datura* does not result from the failure of fertilization. In this case the fertilization proceeds normally and is followed by the formation of a $2n$ embryo and a $3n$

Explanation of figures 16–21

FIG. 16. Embryo-sac with young proembryo, well developed endosperm and normal-appearing endothelium. FIG. 17. Embryo-sac contents degenerating, endothelium cells largely unaltered. FIG. 18. Embryo-sac contents beginning to degenerate. Endothelium cells enlarged. Chalazal opening clearly shown. FIG. 19. Degenerated embryo-sac contents and endothelium. FIG. 20. Ingrowth of endothelium at micropylar end of embryo-sac, degenerated contents at chalazal end. Chalazal opening evident. FIG. 21. Cross section through embryo-sac filled with endothelium cells. Figures 16–17 from *D. stramonium* × *D. ceratocaula* crosses; figures 18–21 from *D. stramonium* × *D. metel* crosses.


16.
17.
18.
19.
20
50μ
21.

endosperm, as was shown by direct observation of various stages of fertilization as well as by chromosome counts in dividing zygote and endosperm nuclei. Additional observations made recently on fertilized ovules of *D. stramonium* × *D. metel* and new observations on ovules of *D. stramonium* × *D. ceratocaula* have shown that the early stages are much the same as in the *D. stramonium* normal $2n$ and $4n$ controls as well as in incompatible crosses just discussed. In the ovules from $2n \times 2n$, $4n \times 4n$, $4n \times 2n$, and reciprocal crosses, the fertilized central nucleus divides usually three days after pollination and the division of the zygote occurs on the fourth or more frequently on the fifth day after pollination, i.e., not before the endosperm cells go through their fourth or fifth divisions. Figure 16 illustrates a fertilized ovule from a *D. stramonium* × *D. ceratocaula* cross, fixed 6 days after pollination. The proembryo, which has about 4 cells, and the well developed endosperm are surrounded by a single-layered endothelium. The opening in the endothelium layer which forms a communication between the contents of the embryo-sac and the outer maternal tissue at the chalazal end is seen in figures 18 and 20.

The rate of development of the proembryo and endosperm in the hybrids, if compared with that in the control, slows down soon after the division of the zygote. Usually seven or eight days after pollination, in some cases earlier, in others later (about the 10th or even the 13th day in *D. stramonium* × *D. ceratocaula*) the contents of the ovules degenerate (figs. 17, 18, 19). The disintegration may occur first in either the proembryo or in the endosperm. The cells of the endothelium enlarge in size and may disintegrate (fig. 19) or begin to divide and form a large ingrowth into the embryo-sac (fig.20). A transverse section through such an ovule shows that the ingrowth is formed by several layers of cells which fill the embryo-sac (fig. 21).

In all this behavior the incompatible species crosses closely parallel the behavior of the $4n \times 2n$ cross and its reciprocal. It seems remarkable that tetraploid-diploid crosses within a single species should show such similarity to crosses between diverse species. The breakdown in the species crosses has been generally assumed to be due to incompatibility of genes, but the results of the tetraploid-diploid crosses cannot be accounted for in this way. It would seem that the early stages in the life history of the *Datura* plant must be very critical.

Method of Breakdown. Zygote sterility in which fertilization occurs but the young embryo does not pass a certain early stage in development has been observed in a number of other plants. A case of especial interest is that of alfalfa studied by Brink and Cooper (3). Here 34.4 per cent of ovules were found to collapse after self-fertilization whereas after cross-fertilization only 7.1 per cent collapsed. The breakdown of the endosperm is accompanied by

the enlargement and in-growth of the cells surrounding the embryo-sac as in *Datura*. In their crosses the rate of division is higher than in self fertilized seeds—owing, they believe, to the effects of hybrid vigor. They suggested that the supply of nutrient materials is shared between the integument and endosperm and that the growing hybrid endosperm has a better chance to compete with the integument for food supply.

Cooper and Brink (6) found a somewhat similar condition within the genus *Nicotiana* in that certain incompatible species crosses showed an early disintegration of embryo and endosperm. This disintegration they attribute to the fact that the nourishment for the developing endosperm is cut off by closure of the connection at the chalazal end between the embryo-sac contents and the outer maternal tissue. It is doubtful if such an explanation can be held for the condition in the incompatible crosses discussed in *Datura*. In our material the opening at the chalazal end (figs. 10, 18, 20) is evident before fertilization and remains open during the development and disintegration of the embryo-sac contents. In all serial sections from compatible crosses which we have examined in *Datura*, the connecting opening can be demonstrated. No difference has been found in respect to this opening between the controls and the incompatible crosses.

The authors just quoted attribute the disintegration observed to starvation of endosperm brought about by excessive growth of the adjacent maternal tissue which they believe precedes the collapse of the endosperm and always starts at the chalazal end.

In regard to the sequence in which the different tissues begin to degenerate, our investigations cannot give a definite conclusion. Endosperm, proembryo, and endothelium are all subject to disintegration. In the incompatible intra se crosses a considerable number of cases have been observed in which the degeneration appears to have been initiated by the endosperm. Disintegration in the large cells of the endosperm, however, is more readily observed than in the denser cells of the proembryo and the observations therefore cannot be used to establish the sequence in which disintegration is iniated. In the species crosses there were apparently clear cases in which the proembryo began to disintegrate first. At the present time it seems unsafe to attribute the disintegration of the proembryo to that of the endosperm, either because the supply of nutrient is blocked or for other reasons. In our material the disintegration and ingrowth of maternal tissue appear sometimes to start at the chalazal and sometimes at the micropylar end.

SUMMARY

In the incompatible $4n \times 2n$ and reciprocal crosses in *Datura stramonium* as well as in the incompatible species crosses, *D. stramonium* × *D. metel* and *D. stramonium* × *D. ceratocaula*, the early stages are similar to those in com-

patible controls. The endosperm nucleus divides first and reaches about the fifth division before the zygote begins to divide. After a few divisions in the proembryo of incompatible crosses, disintegration takes place in both proembryo and endosperm. At this time also the cells of the single-layered endothelium which surrounds the embryo-sac enlarge and either form a mass of cells in the embryo-sac or themselves disintegrate.

The ratios between chromosome numbers in respect to embryo, endosperm, and maternal tissue in the $4n \times 2n$ and in the $2n \times 4n$ incompatible crosses are respectively larger and smaller than the ratios between corresponding tissues in the compatible controls ($2n \times 2n$ and $4n \times 4n$). How such deviations from the chromosome ratios in the compatible crosses can bring about the observed disintegrations or what other factors are involved is at present unknown.

CARNEGIE INSTITUTION OF WASHINGTON
COLD SPRING HARBOR, N. Y.

Literature Cited

1. **Blakeslee, A. F., Belling, John & Farnham, M. E.** 1923. Inheritance in tetraploid *Daturas*. Bot. Gaz. **76**: 329–373.
2. **Blakeslee, Albert F.** 1941. Effect of polyploidy in plants. Am. Nat. **75**: 117–135.
3. **Brink, R. A. & Cooper, D. C.** 1939. Somatoplastic sterility in *Medicago sativa*. Science **90**: 545–546.
4. **Buchholz, J. T. & Blakeslee, A. F.** 1927. Pollen-tube behavior with reference to sterility in *Datura*. Mem. Hort. Soc. N. Y. **3**: 245–260.
5. **Buchholz, John & Blakeslee, A. F.** 1929. Pollen-tube growth in crosses between balanced chromosomal types of *Datura stramonium*. Genetics **14**: 538–568.
6. **Cooper, D. C. & Brink, R. A.** 1940. Somatoplastic sterility as a cause of seed failure after interspecific hybridization. Genetics **25**: 593–617.
7. **Dark, S. O. S.** 1931. Chromosome association in triploid *Primula sinensis*. Jour. Genet. **25**: 91–95.
8. **Dermen, Haig.** 1931. Polyploidy in *Petunia*. Am. Jour. Bot. **18**: 250–261.
9. **Ledingham, G. F.** 1940. Cytological and developmental studies of hybrids between *Medicago sativa* and a diploid form of *M. falcata*. Genetics **25**: 1–15.
10. **Levan, Albert.** 1936. Zytologische Studien an *Allium Schoenoprasum*. Hereditas **22**: 1–128.
11. **Randall, T. R.** Triploidy in *Vitis vinifera* (in press).
12. **Satina, S. & Blakeslee, A. F.** 1935. Fertilization in the incompatible cross *Datura stramonium* × *D. metel*. Bull. Torrey Club **62**: 301–312.
13. **Van Overbeek, J., Conklin, Marie E. & Blakeslee, A. F.** 1941. Chemical stimulation of ovule development and its possible relation to parthenogenesis. Am. Jour. Bot. **28**: 647–656.

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 421–428 JUNE, 1942

THIAMINE IN SOME COMMON AMERICAN TREES[1]

P. R. BURKHOLDER AND A. G. SNOW, JR.

The importance of thiamine (vitamin B_1) in metabolism and growth of plants and animals has become well established in recent years. Comparatively little quantitative work has been done, however, with the vitamin relations of woody plants. Dagys (1936) demonstrated in expanding buds of trees the presence of a substance which stimulates cell division in cultures of yeast. Enders and Hegendorfer (1941) similarly reported on yeast growth factors contained in trees. Growth stimulation of *Phycomyces* by extracts from leaves of many species of trees was described by Schopfer (1936). The vitamin B_1 content of leaves of several woody species grown in sand or soil culture in California was studied by Bonner and Greene (1939) with a modification of Schopfer's method. These authors claimed that species such as *Camellia japonica* and *Daphne odora*, which are low in naturally occurring vitamin B_1, can be stimulated to grow more rapidly by supplying synthetic thiamine to their roots. Other investigators have not been able to obtain any growth-promoting effects by the addition of synthetic thiamine to the roots of many species (Hamner 1940). In view of the widespread biological importance of thiamine, further knowledge concerning the occurrence of this vitamin in trees may be of practical significance for certain problems in forest genetics, silviculture, and wild life management.

DISCUSSION OF METHODS

Of the known methods available for determination of thiamine in plant tissues, one very sensitive and simple quantitative test involves the use of the fungus *Phycomyces blakesleeanus*. Growth of this fungus is controlled largely by the amount of thiamine (Schopfer 1934) or its components, pyrimidine and thiazole, supplied in culture media (Robbins and Kavanagh 1937, 1938a, 1938b; Bonner and Erickson 1938; Bonner and Buchman 1939). The *Phycomyces* assay method measures the cumulative activity of thiamine, its two components, and cocarboxylase. All of these are active too in the metabolism and growth of higher plants, but animals appear to use only the whole thiamine molecule (Harris 1938). It is known also that unidentified substances in tissue extracts added to synthetic media may stimulate somewhat the growth of the fungus in the presence of thiamine (Robbins and Hamner 1940). Hence it should be recognized that this biological assay method gives only an approximation of the thiamine and related compounds

[1] Joint contribution from Osborn Botanical Laboratory, Yale University, and Northeastern Forest Experiment Station, New Haven, Conn.

contained in tissues. However, the reliability of the method has been tested by Bonner and Greene (1939) who reported that known amounts of thiamine added to ground leaf tissue could be recovered quantitatively in the *Phycomyces* test.

In our experiments it was found that thiamine added to preparations of plant material, such as elm buds, etc., could be recovered. The accuracy with which the method allowed recovery of synthetic thiamine from media containing extracts of tissues varied somewhat among the species of trees selected for study. The recovery from extracts of some species, such as sugar maple, was very inefficient. It appears that growth-inhibiting substances as well as growth-promoting factors must be recognized in evaluating results obtained with the *Phycomyces* method. Some of the difficulties encountered in using the method have been emphasized earlier by Sinclair (1938).

The methods used for determining the approximate thiamine activity of buds, leaves, and bark of trees at different seasons of the year are essentially those which were reported in an earlier paper (Burkholder and McVeigh 1940). For each analysis approximately 100 mg. of fresh tissue were weighed rapidly on a dampened analytical balance, and ground fine in the acid nutrient solution with a glass mortar and pestle. The nutrient solution containing the ground tissue was placed in 125 ml. Erlenmeyer flasks plugged with cotton, and autoclaved at 15 pounds for 15 minutes. Inoculation was made from a pure spore suspension of *Phycomyces*. After growing at 20° C. for 10 days dry weights of the washed fungus mats were determined. By reference to standard growth curves obtained with the fungus cultivated in a series of synthetic nutrient solutions with known amounts of thiamine, the approximate thiamine activity of the samples of tissue was estimated. Although it seems probable that most of our estimated data may be somewhat too high because of the growth-stimulatory factors other than thiamine presumably supplied by the tissues, it is thought that the assays possess comparative value. Replications during sampling made it possible to determine the statistical significance of the data according to the methods of Fisher (1936).

RESULTS

Inhibition of Growth of Phycomyces. Preliminary experiments with *Phycomyces blakesleeanus* indicated that growth of the fungus is inhibited by addition to the culture medium of materials from certain deciduous trees. Extracts from species such as *Quercus alba* and *Acer saccharum* produced particularly strong inhibition of growth. A comparative study was then made on the effects of ground leaves of sugar maple, Maryland Mammoth tobacco, and Marglobe tomato upon growth of *Phycomyces* in the basal medium containing 10^{-6} M synthetic thiamine. Three replications of each

treatment were made and after growth for 10 days the response of the fungus was determined by measuring the dry weight of the mats. The amount of fresh tissue added to each culture flask varied from 25 to 800 mg. Controls were run with no tissues added to the basal medium.

Some of the results obtained in these experiments are shown graphically in figure 1. Increasing the supply of ground tissues of these particular vari-

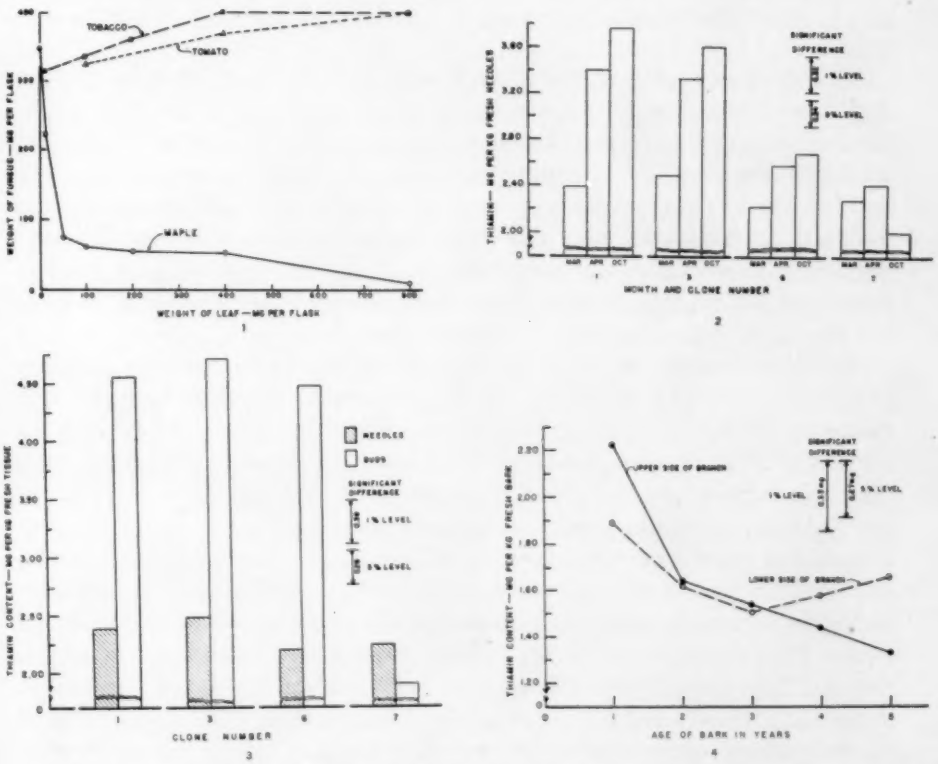


FIG. 1. Influence of increments of ground fresh leaf tissue of Maryland Mammoth tobacco, Marglobe tomato, and sugar maple on growth of *Phycomyces* in nutrient solution containing synthetic thiamine. Sugar maple inhibits growth of the fungus. FIG. 2. Thiamine activity in needles of four white pine trees sampled on March 15, April 30, and October 11, 1941. Significant differences occur among the individual trees and at different times. FIG. 3. Thiamine activity in needles and buds of white pine trees sampled on March 15, 1941. Significant differences occur between needles and buds of trees number 1, 3, and 6, but not in tree 7. FIG. 4. Distribution of thiamine in bark of white pine branches sampled along the upper and lower sides at 5 levels from tip to base on May 7, 1941.

eties of tobacco and tomato exerted no deleterious effect on growth of the fungus, but actually brought about some increase in dry weight. In contrast with cultures containing these tissues, the addition of even small amounts of

leafy material from sugar maple greatly reduced the dry weight of the fungus. It is obvious that the simplified *Phycomyces* assay for thiamine can not be employed for tissues of all kinds of plants. It seems probable that unidentified substances present in leaves of sugar maple may be responsible for inhibition of growth of *Phycomyces*. There is some evidence to indicate growth-inhibiting substances also in buds of Norway maple and in species of oak. No evidence of such inhibitory action was found in red maple or any of a number of other species of trees.

Stimulation of Growth of Phycomyces by Extracts from Evergreen and Deciduous Trees. Studies were made on the thiamine activity of needles, buds, and bark samples taken from a number of selected 12-year-old white pine trees in North Branford, Connecticut. The purpose of the investigations was to obtain some indication of the occurrence of the vitamin in different parts of evergreen trees, the possible variation among different individual trees of the same species, and the extent of fluctuation in vitamin content at different times during the year. Approximately 100 mg. of fresh needles, bark, or buds were used for each assay.

Investigations of individual variation in white pine involved the sampling of 10 different trees which are being used as source material for establishing clones by vegetative propagation. The results of assays on the vitamin B_1 content of fresh needles of four of these trees are reported here to indicate the nature of the variations found in response of *Phycomyces* to this coniferous material. A more extensive report on growth habits and distribution of thiamine in these trees is planned for a later paper. Needles of the last season's growth were collected from three branches of 1937 origin on each tree, and after thorough mixing three random samples were taken for replicate assays. The calculated values for thiamine in the needles of trees number 1, 3, 6, and 7, sampled March 15, April 30, and October 11, 1941, are indicated in figure 2. Trees 1 and 3 were richer in thiamine than were 6 and 7. These four examples represent the rich and poor types in the group of 10 trees studied. It appears that in those trees which showed a higher content of thiamine in early spring the vitamin content increased considerably during the growing season. Trees 1 and 3 showed significant increases in vitamin from March through April to October, but trees 6 and 7 exhibited little or no significant increases with advance of the summer season. It must be admitted here that any correlation of thiamine content with growth and general vigor of the trees must await further study.

On October 11, 1941, two grams of fresh leaf material from each tree were oven-dried at 70° C. and weighed to allow the calculation of thiamine on a dry weight basis. Since it was found that the dry matter was in all the samples taken about 42 per cent of the fresh weight, it would seem to make

little difference whether the thiamine values are expressed on the basis of the fresh or dry weight of tissues from these trees.

Determinations of thiamine in the buds of the trees were made on March 15, 1941. A comparison of the data for needles and buds is presented in figure 3. In trees 1, 3, and 6, the vitamin was far more abundant in the buds than in the leaves, but in tree number 7 there was little significant difference between the values for the two regions.

On May 7, 1941, the distribution of thiamine in the 1-, 2-, 3-, 4-, and 5-year-old bark of three white pine trees was determined with 3 replicate samples from each region selected from both the upper and lower sides of a 5-year-old branch. The averaged data are shown graphically in figure 4. A gradient in vitamin distribution exists in the upper side of the branches ranging from a high concentration in the 1-year-old bark taken from near the tip of the branch downward to the 5-year-old portion of the branch. This significant trend in the upper side was not found in the lower side of these same branches. Just what meaning the data may have for growth and development is not clear. The facts do indicate the need for careful sampling technique in any attempt to analyze the vitamin distribution in trees.

The buds and leaves of eight species of deciduous trees located on the Yale campus were examined for thiamine activity in six different months during 1941. Three replicate determinations were made on each kind of fresh material assayed on each of six sampling dates.

The averaged data for estimated thiamine in buds and leaves of these trees are presented in table 1. The values expressed as milligrams of thiamine

TABLE 1

Estimated thiamine (as mg. per kg. fresh tissue) in buds and leaves of trees sampled at different times during 1941. The blanks indicate no assays

Date sampled (1941)	3/24	4/18	5/9	7/12	10/12	11/25
	Buds	Buds	Leaves	Leaves	Leaves	Buds
Aesculus hippocastanum	4.4	4.0	4.4	3.5	5.5	5.6
Fagus sylvatica	6.1	6.8	6.4	4.4	4.9	.....
Platanus occidentalis	4.1	3.7	3.7	.....	2.3	.....
Acer platanoides	0.0	1.4	2.3	.....	2.8	.....
Acer rubrum	.....	4.6	2.8	3.3	3.5	7.4
Ulmus americana	.....	3.4	3.3	2.9	3.1	6.3
Quercus palustris	3.3	0.6	0.0	.....	0.0	3.7
Cornus florida (flowering branch)	0.6	0.2	0.2	.....	.....	.....
Cornus florida (vegetative branch)	3.5	1.3	1.0	.....	2.5	.....

per kilogram of fresh tissues show some variation among the species. The assays for *Quercus palustris* tended to be low during the summer months.

A few determinations made on *Q. alba* produced very little growth of *Phycomyces*. As mentioned above, it seems probable that unidentified substances in the oaks and some maples interfere with the assay by inhibiting growth of the fungus. Leaves and buds from flowering branches of *Cornus florida* also permitted but little growth of the fungus as compared with the vegetative shoots from another tree of the same species. The data indicate in general a widespread occurrence of thiamine in the buds and leaves of trees at different seasons of the year. The buds of red maple and elm contained larger amounts of the vitamin in the fall than when tested in the spring. The values in general agree well with biological assays on certain woody plants as reported by Bonner and Greene (1939).

Distribution of Thiamine in Ringed Trees. Some preliminary experiments were performed to determine whether removing a ring of bark from trees would influence the distribution of thiamine. Young trees of basswood, red maple, and white pine were girdled by removing a ring of bark from the lower portion of the main trunk. The bark was assayed for thiamine at the time of ringing. After the lapse of from 1 to 4 months samples of the bark just above and below the ring were assayed.

Five 3-year-old white pine trees were ringed on March 15 and tested again on April 30, 1941. After the girdling operation depletion of the vitamin was greater above than below the ring at this season of the year. It is suggested that perhaps some form of thiamine or its precursors stored in the plant body aided in maintaining a comparatively high value for a while in the bark. Unfortunately the plants perished before assays could be made in midsummer.

Two small trees of red maple growing in the greenhouse were ringed on March 24. After one month somewhat more of the vitamin was found in the bark below than above the ring. After 4 months, however, there was five times as much vitamin above as below the ring. The values after four months were as follows: bark above the ring, 5.7 and 3.5; and below the ring, 0.8 and 0.9 mg. per kg. Two basswood trees about three inches in diameter were ringed on March 15. At the time of ringing the bark assayed 1.0 and 0.9 mg. per kg. of fresh tissues. About four months later (on July 12) the determinations were as follows: bark above the ring, 5.4 and 4.2; and below the ring, 0.8 and 1.0 mg. per kg.

From the data on white pine and red maple it seems that a short time after ringing a tree in early spring, the amount of vitamin per unit of fresh bark is depleted less rapidly below than above the ring. In contrast to this temporary condition the data obtained with ringed basswood and red maple suggest that after a longer time impedance of transport downward from the leaves may result in accumulation of vitamin in the bark just above the ring.

Bonner (1940) has reported the inhibition of transport of thiamine across zones of tomato stem which had been killed by steam. Presumably the supplies below the ring in a girdled tree are finally almost completely exhausted. Possibly girdled trees may ultimately die not alone from food starvation but from extreme depletion of vitamins necessary for the roots.

SUMMARY

The approximate thiamine activity as indicated by the *Phycomyces* assay of buds, leaves, and bark of some common American trees was studied at different seasons of the year.

Significant differences in stimulation of *Phycomyces* by extracts of tissues were found among individuals of white pine, between the needles and buds, and at different levels in the bark of these trees.

Both buds and leaves of sugar maple and white oak inhibited growth of *Phycomyces* in nutrient solutions to which had been supplied amounts of synthetic thiamine more than enough for normal growth of the fungus. Crude extracts from such species cannot be assayed for thiamine with the simplified method. Extracts from red maple and many other trees had no such inhibitory influence.

The buds and leaves of several species of deciduous trees sampled at different seasons of the year showed varying degrees of effectiveness in promoting growth of *Phycomyces*.

In the bark of young trees girdled in early spring, less thiamine activity was found above than below the girdle after 4 to 6 weeks. After about four months, however, substances showing thiamine activity accumulated in the bark above the ring probably as a result of inhibited translocation downward from the leaves. It seems possible that girdled trees may ultimately die from vitamin starvation of their root systems.

OSBORN BOTANICAL LABORATORY, YALE UNIVERSITY
AND
NORTHEASTERN FOREST EXPERIMENT STATION
NEW HAVEN, CONNECTICUT

Literature Cited

Bonner, J. 1940. On the production and transport of thiamin in the tomato plant. Am. Jour. Bot. **27**: 21s.

Bonner, J. & Buchman, E. R. 1939. The synthesis and destruction of vitamin B_1 by *Phycomyces*. Proc. Nat. Acad. **25**: 164–171.

Bonner, J. & Erickson, J. 1938. The *Phycomyces* assay for thiamin (vitamin B_1): the method and its chemical specificity. Am. Jour. Bot. **25**: 685–692.

Bonner, J. & Greene, J. 1939. Further experiments on the relation of vitamin B_1 to the growth of green plants. Bot. Gaz. **101**: 491–500.

Burkholder, P. R. & McVeigh, Ilda. 1940. Studies on thiamin in green plants with the *Phycomyces* assay method. Am. Jour. Bot. **27**: 853–861.

Dagys, J. 1936. Die Hefewuchsstoffe in Knospen und Blattern. Protoplasma **26:** 20–44.

Enders, C. & Hegendorfer, M. 1941. Hefewuchsstoffe in Holz. Biochem. Zeits. **307:** 120–122.

Fisher, R. A. 1936. Statistical methods for research workers. Oliver and Boyd, London.

Hamner, C. L. 1940. Effects of vitamin B_1 upon the development of some flowering plants. Bot. Gaz. **102:** 156–168.

Harris, L. J. 1938. Vitamins and vitamin deficiencies. 204 pp. Churchill, London.

Robbins, W. J. & Hamner, K. C. 1940. Effects of potato extracts on growth of *Phycomyces*. Bot. Gaz. **101:** 912–927.

Robbins, W. J. & Kavanagh, F. 1937. Intermediates of vitamin B_1 and growth of *Phycomyces*. Proc. Nat. Acad. **23:** 499–502.

————. 1938a. The specificity of pyrimidine for *Phycomyces Blakesleeanus*. Proc. Nat. Acad. **24:** 141–145.

————. 1938b. The specificity of thiazole for *Phycomyces Blakesleeanus*. Proc. Nat. Acad. **24:** 145–147.

Schopfer, W. H. 1934. Les vitamines crystallisées B_1 comme hormones de croissance chez un microorganisme (*Phycomyces*). Arch Mikrobiol. **5:** 511–549.

————. 1936. Recherches sur l'action de divers extraits végétaux sur le développement de *Phycomyces*. Arch. Mikrobiol. **7:** 156–176.

Sinclair, H. M. 1938. The estimation of vitamin B_1 in blood. Jour. Biol. Chem. **32:** 2185–2199.

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 429–433 JUNE, 1942

AN ISOLATED COLONY OF PLANTS ON A GLACIER-CLAD MOUNTAIN

WILLIAM S. COOPER

In late July, 1940, Mr. and Mrs. Bradford Washburn and three companions made the first ascent of Mt. Bertha, a difficult peak of the Fairweather Range in the Glacier Bay National Monument, Alaska. In the course of their climb they found patches of vegetation growing in such inhospitable situations that they made collections and later submitted them to me. The set comprises 15 species. Only four are first reports for the Glacier Bay National Monument,[1] but because of the conditions under which they grew, and the occurrence of certain species far from their previously known ranges, the collection is of very special interest.

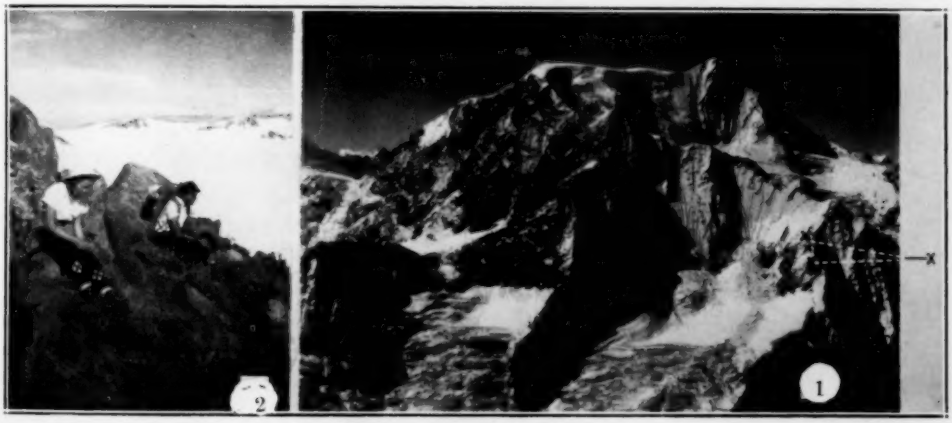


FIG. 1. Mt. Bertha from the southeast. Crosses mark some of the higher spots where collections were made. Aerial photograph by Bradford Washburn. FIG. 2. A patch of vegetation on the southeast ridge of Mt. Bertha at 5000 ft. *Lutkea pectinata* and *Lupinus nootkatensis* are distinguishable. Photograph by Bradford Washburn.

The altitude of Mt. Bertha is 10,182 ft. It constitutes a bastion projecting eastward from the mass of Mt. Crillon, 2500 ft. higher, which stands upon the main divide between Glacier Bay and the ocean. The mountain itself is largely sheathed with ice and snow (fig. 1). Everywhere around it are glacier-clad peaks; the intervening valleys are occupied by névé and ice-streams. Particularly noteworthy is the Brady Ice Field, 30 miles long and 5–10 miles wide, which partially surrounds Mt. Bertha on the east and south. The

[1] Previous lists for the area have been published by the writer: The seed-plants and ferns of the Glacier Bay National Monument, Alaska. Bull. Torrey Club **57**: 327–338. 1931. Additions to the flora of the Glacier Bay National Monument, Alaska, 1935–1936. Bull. Torrey Club **66**: 453–456. 1939.

shortest distances to lowlands bare of snow in summer are westward to the vicinity of Crillon Lake, 14 miles, and northward to Johns Hopkins Fiord, 12 miles. Very high mountains here intervene, and the latter inlet became free of its trunk glacier only within the last half century. To Geikie Inlet, tributary to lower Glacier Bay, the distance is 17 miles. Two centuries ago, when the basin of Glacier Bay was completely filled with ice,[2] distance to unglaciated areas northward and eastward was 40-50 miles.

The plants were collected along the crest of an eastward-projecting spur, mainly on the south exposure, at altitudes ranging from 4100 to 6000 ft. They grew on small patches of gravel between ledges. Some of the higher localities where specimens were gathered are indicated by crosses on figure 1. At the time of collection the rocks in this vicinity were somewhat barer than is shown in the picture, which was taken two weeks later, after a heavy fall of snow. The growing season here is six weeks at the most.

The list of species collected is given below, and comments concerning taxonomy and individual ecology are added. Specimens have been deposited in the herbarium of the University of Minnesota.

LYCOPODIUM SELAGO L. Plants of normal size and character. A typical member of the heath-mat community which is widespread above timberline and occasional below, even to sea-level.

SILENE ACAULIS L. Normal. A common pioneer on gravels, mainly above timberline but occasional even at sea-level.

SAXIFRAGA BRONCHIALIS L. Moderately dwarfed. This and the two following inhabit rock crevices and similar habitats below timberline. They are not characteristically alpine.

SAXIFRAGA PUNCTATA L. One-third to one-half the average height at lower altitudes. First report for National Monument.

SAXIFRAGA TRICUSPIDATA Rottb. Normal size for Alaska specimens.

LUTKEA PECTINATA (Pursh) Kuntze. A characteristic member of the heath mat. Basal leaves small, short-stalked, in crowded rosettes; stem leaves abruptly reduced, very small.

LUPINUS NOOTKATENSIS Donn. Very much dwarfed. A typical lowland plant, abundant in various meadow communities, where it grows to a height of at least 3 feet. The highest point where this species was found was at 5000 ft.

EPILOBIUM LATIFOLIUM L. Dwarfed. Leaves and flowers one-half to two-thirds the size of lowland specimens.

PHYLLODOCE GLANDULIFLORA (Hook.) Coville. Normal except that leafy stems are very short. A characteristic heath-mat species.

POLEMONIUM HUMILE Willd. Somewhat dwarfed, leaflets smaller than

[2] **Cooper, W. S.** The problem of Glacier Bay, Alaska: a study of glacier variations. Geogr. Rev. **27**: 37–62. 1937. A map accompanying this paper shows the location and surroundings of Mt. Bertha.

average, pubescence more abundant, especially in inflorescence. An apparently delicate plant of the subalpine forest. First report for National Monument.

CAMPANULA LASIOCARPA Cham. Plant normal in height ($\frac{1}{2}$–2 inches); flower larger than normal. A characteristic alpine species.

ANTENNARIA ISOLEPIS Greene.

ANTENNARIA MEDIA Greene.[3] In studying the small set of three individuals of Antennaria, my first assumption was that they were all *A. borealis* Greene, which I have collected frequently at low altitudes around Glacier Bay and Prince William Sound. It turned out, however, that according to the treatments by Greene[4] and Malte[5] (the only pertinent ones) two species are represented, neither being *A. borealis*. These two, moreover, have ranges distinct and far-separated so far as known, both very distant from Glacier Bay.

A. media is a cordilleran high-mountain species ranging from the central Sierras north to southern British Columbia and eastward to Glacier Park and the Wasatch Mountains. The nearest known stations to Glacier Bay are Mt. Arrowsmith, Vancouver Island, and Griffin Lake, near Revelstoke, 800 and 900 miles distant respectively. The specimens match very perfectly the abundant material in the herbarium of the University of Minnesota. They are pistillate plants, as is also the single specimen of *A. isolepis*.

A. isolepis ranges "from Labrador and northern Quebec to Keewatin and perhaps farther west."[6] The single individual checks perfectly with Malte's description and with two specimens from the Torngat region from collections cited by Malte. The nearest known authentic localities are near the west coast of Hudson Bay, 1400 miles distant from Mt. Bertha. Polunin,[6] however, mentions a somewhat doubtful specimen from Mt. Selwyn, B.C. (lat. 56° N, long. 123° 30′ W), which is only 500 miles from Mt. Bertha.

It is of course true that the regions lying between Glacier Bay and the known ranges of the two species have been very inadequately explored. It is rather startling, however, that a cordilleran and an arctic species should first be detected in the far northwest perched in close company upon a lofty ridge surrounded by miles of glaciers; in a region, moreover, that has enjoyed a fair amount of botanical exploration, at least at low altitudes.

HIERACIUM GRACILE var. MINIMUM A. Nelson. Two inches in height; normal for the alpine variety.

SOLIDAGO MULTIRADIATA var. SCOPULORUM A. Gray. Two inches in height; normal for the alpine variety.

---

[3] I wish to thank Drs. F. K. Butters, C. W. Sharsmith, and J. W. Moore for assistance in identifying this interesting pair of species.

[4] **Greene, E. L.** Studies in the Compositae: Some northern species of *Antennaria*. Pittonia **3**: 273–289. 1898. New species of *Antennaria*. Pittonia **4**: 81–85. 1899. Some Canadian Antennarias. Ottawa Naturalist **25**: 41–43. 1911.

[5] **Malte, M. O.** Antennarias of arctic America. Rhodora **36**: 101–117. 1934.

[6] **Polunin, Nicholas.** Botany of the Canadian eastern Arctic. Nat. Mus. Canada Bull. 92 (Biol. Series 24). 1940.

The collection is admittedly incomplete, and therefore an adequate characterization of the plant community is impossible. Mr. Washburn makes one suggestion, however, that is significant. He writes that "the flowers occurred in little patches of anywhere from two or three feet to fifteen or twenty feet long. Some of these patches were typical 'turf-banked terraces'; others were sunny spots sheltered by surrounding loose rocks or ledges" (see figure 2). The turf was from two to three inches thick. This suggests the presence of minute samples of the characteristic alpine mat of southeastern Alaska. Three of the species collected are typical members of that community: *Phyllodoce glanduliflora*, *Lutkea pectinata*, and *Lycopodium selago*. Four others are definitely arctic-alpine: *Silene acaulis*, *Campanula lasiocarpa*, and the two Antennarias. The remaining eight are not characteristically alpine. Two species, *Lupinus nootkatensis* and *Polemonium humile*, the first ordinarily found in sea-level meadows, the second in moist sheltered spots in the subalpine zone, seem particularly out of place among these snowbanks. Although dwarfed, they appear otherwise normal and healthy. In general, the subalpines are more or less dwarfed while the characteristic alpines are normal in size.

Two questions present themselves: How did these plants reach their present position, and how long have they been there? Six species, *Lycopodium selago*, *Epilobium latifolium*, *Hieracium gracile*, *Solidago multiradiata*, and the Antennarias, have disseminules more or less well fitted for transportation by wind. These might perhaps have been wafted over the 15 miles or more of ice fields separating them from possible sources. The others have small seeds, except *Lupinus nootkatensis* which has large, heavy ones. Wind transportation of small seeds across the névé of the Brady Ice Field, perhaps by repeated jumps, with a final lift to the slopes of Mt. Bertha by violent ascending air currents, is conceivable. The entire trip, however, would have to be completed between the time of seed ripening and the onset of winter snow; otherwise, in this region of tremendous snowfall, hopeless burial would take place.

If the barriers to migration appear formidable today, they were even more so two centuries ago, when the whole area tributary to Glacier Bay was buried under ice. The gathering of this diverse assemblage of species in so limited and isolated a spot, under present conditions or worse, even granting a century or two for the process, and particularly in view of the presence of a turf mat, the development of which is a slow process, puts a serious strain upon the imagination.

A much more easily tenable hypothesis is that there has been a continuous plant population high on the slopes of the mountain for a very long time, and that it arrived during a period when glaciation was considerably less extensive than now, when easy migration routes led from the lowlands to the

upper slopes, and when areas suitable for alpine vegetation were more widespread in the immediate vicinity.

A period of this character has been demonstrated for the Glacier Bay region. The glaciers in their retreat are still uncovering the remains of forests which existed when the ice fields were considerably less expanded than they are today.[7] The cause of glacier contraction was presumably the onset of climatic conditions relatively unfavorable to snow precipitation and preservation—of comparative warmth or dryness or both. It was followed by return to conditions favoring glacier expansion, which have persisted into recent time.

This sequence agrees with the post-Pleistocene climatic history that has been tentatively worked out for northern North America in general and for northern Europe as well. The scheme, whose formulation is due principally to von Post, postulates a period of comparative warmth and dryness in mid-post-Pleistocene time followed by a return to conditions moderately cool and moist. There is North American evidence for it from a number of independent fields, which has been summarized by several writers.[8] The history of the plant population of Mt. Bertha here suggested may be fitted into this scheme with no contradiction of known facts.

It is natural to assume that other similar isolated colonies exist. Mr. Washburn, who has seen more of the higher parts of the Fairweather Range than any other person, has found none there. From the St. Elias Range, however, he reports "small patches of flowers very similar to these about thirty miles from timber on a little rock island [in the ice fields]." Dr. F. K. Butters has seen patches of alpine plants inhabiting high ridges in the Selkirks surrounded by miles of snow fields. A particularly interesting case is the finding of *Loiseleuria procumbens* in such a situation—this being its only recorded occurrence in the Selkirk Mountains. It is quite possible that directed search would show that such isolated colonies are by no means rare among glacier-clad mountains.

A final suggestion: if these colonies have held on in isolation through several thousand years of glacial rigor, is it not equally believable that similar ones may have survived on nunataks through one or even more of the continental ice floods of the Pleistocene?

DEPARTMENT OF BOTANY, UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA

[7] **Cooper, W. S.** The problem of Glacier Bay, Alaska: a study of glacier variations. Geogr. Rev. **27**: 37–62. 1937.

[8] **Sears, P. B.** Glacial and postglacial vegetation. Bot. Rev. **1**: 37–51. 1935. **Cain, S. A.** Pollen analysis as a paleo-ecological research method. Bot. Rev. **5**: 627–654. 1939. **Eiseley, L. C.** Pollen analysis and its bearing upon American prehistory: a critique. Amer. Antiquity **5**: 115–139. 1939. **Cooper, W. S.** Vegetation of the Prince William Sound region, Alaska; with a brief excursion into post-Pleistocene climatic history. Ecol. Monogr. **12**: 1–22. 1942.

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 434–437 JUNE, 1942

A NEW TETRAPLOID WHEATGRASS FROM NEVADA

JOSEPH H. ROBERTSON AND LLOYD WEAVER[1]

A group of extremely large plants of *Agropyron spicatum* (Pursh) Scribn. and Smith, has been observed growing near the Paradise Valley Substation, Intermountain Forest and Range Experiment Station, four-and-one-half miles west of the town of Paradise Valley in Humboldt County, Nevada. These plants were first noticed during the summer of 1940. The associated species are all of normal stature and include the following: *Artemisia tridentata, Purshia tridentata, Elymus condensatus, Bromus tectorum, Stipa thurberiana, Agropyron spicatum, Astragalus whitedii,* and *Balsamorhiza sagittata.* This community occupies an irregular area of some 10 square rods on very fine sandy loam sloping gently to the southeast toward Lamance Creek.

FIG. 1. A tetraploid plant (left) and a normal plant (in hand) of *Agropyron spicatum,* and a clump of *Elymus condensatus* (right). Paradise Valley, Nevada, October 1940. U. S. Forest Service Photo.

So robust are the large plants of *Agropyron* that casual observation failed to distinguish them from the giant wild-rye (*Elymus condensatus*) preva-

[1] Jr. Range Examiner, Intermountain Forest and Range Experiment Station, Forest Service, U. S. Dept. of Agriculture, Ogden, Utah; and Assistant in Botany, Osborn Botanical Laboratory, Yale University, New Haven, Connecticut, respectively.

lent in the community (fig. 1). In nearly all macroscopic characters the giant form is approximately twice as large as plants of the normal variety growing on the same site (table 1).

TABLE 1

Comparative measurements[a] of gross characters of normal and giant varieties of Agropyron spicatum near Paradise Valley, Nevada

Character	Normal	Giant
Diameter of bunch, range	15–30 cm.	8–74 cm.
Height of culms, average	60 cm.	120 cm.
Leaf width,[b] average	2.8 mm.	7.0 mm.
Leaf length,[c] average	16.5 cm.	34.5 cm.
Ratio: Leaf length to width	58.9: 1	49.3: 1
Length of spike, average	11.5 cm.	18.7 cm.
Length of spike, range	5–18 cm.	10–23 cm.
Length of spikelet,[d] average	16.8 mm.	23.6 mm.
Dry weight,[e] herbage	35 gm.	77 gm.
Percentage seed germination, 1941	24	0

[a] Although no basis for statistical comparison is available, these data were obtained from 5 representative plants of each form, and are believed to be unbiased and to represent real differences.
[b] Widest portion of third culm leaf below the spike.
[c] Same leaf as the preceding.
[d] Spikelets at center of spike; awns excluded.
[e] Bunches of equal diameter, 15 cm.

Despite its greater size and yield per plant, the value of the giant variety as a range forage plant is not established. No viable seed was produced by either the giant or the normal variety in 1940. In spite of apparently favorable rainfall in 1941, only seed of poor quality was obtained from the normal *Agropyron spicatum*, while that from the adjacent giant plants was entirely nonviable (table 1). It does spread by short, stout rhizomes, and the presence of bunches of various diameters is evidence that occasional crops of viable seed have been cast.

In October 1940, a bunch was divided and the clons potted in the greenhouse at Ogden, Utah. Some of the greenhouse material was sent in March 1941 to the Osborn Botanical Laboratory of Yale University for study. This study consisted of chromosome counts of mitotic figures in root tips and a comparison of sizes of stomata and epidermal cells of the leaves.

Root tips of the giant *Agropyron* were fixed in CRAF solution, embedded in paraffin, sectioned, and stained by means of the Feulgen reaction.

Mitotic figures were not numerous in the root tips, but enough polar views of metaphase plates were present to make possible eight chromosome counts. In addition, a number of figures showed an indefinite number of chromosomes; in all cases more than 14 chromosomes were distinguishable. Of the eight cells mentioned above, one clearly contained 28 chromosomes (fig. 2) and the other seven showed from 21 to 25 with the probability of

additional ones in places where chromosomes were coiled about one another in such a way as to make definite identification of individuals impossible.

Peto[2] recognized the chromosome number of *A. spicatum* as $2n = 14$. The occurrence of 28 somatic chromosomes in root-tip cells of the large plant, supplemented by identification of the form as *A. spicatum* at the Bureau of Plant Industry in Washington, D. C. (U. S. Nat. Herb. No. 90907), as well as by Dr. Bassett Maguire of the herbarium at the Utah State Agricultural College, Logan, Utah, seems sufficient to establish the fact that the giant is a tetraploid form of *A. spicatum*.

Blakeslee and Warmke[3] and others have used gross and semi-microscopic morphological characters such as larger pollen grains in $4n$ flowers, larger

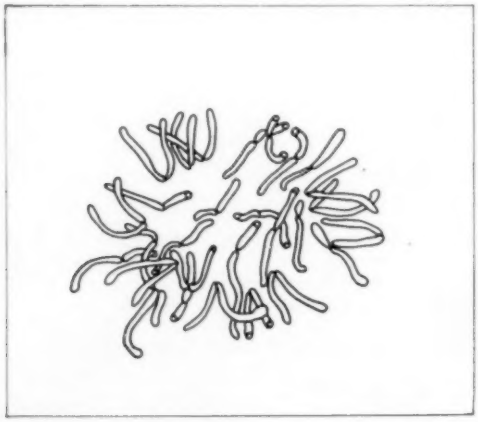


FIG. 2. Polar view of mitotic metaphase from a root tip of the giant *Agropyron spicatum*. Approximately × 2500.

$4n$ seeds, larger stomata, leaves increased in width and thickness, larger size of floral parts, and shorter, stouter fruits as criteria of polyploids. In this species, however, no significant difference was found in size of stomata of the tetraploid as compared with the diploid. An examination of table 1 shows a pronounced decrease in ratio of length to width of the tetraploid leaves. Spikelets are larger than on the diploid form, and the entire inflorescence is appreciably larger in the giant form.

Interspecific hybridization as a means of origin of new *Agropyron* species is discussed by Peto (1930), who cites instances of natural hybridization between *A. cristatum* and *A. repens* var. *glaucescens* in Russia and between *A. junceum* and *A. repens* in Denmark. The hybrids mentioned were similar in form to entirely different species of the genus. It is barely possible that the giant form here discussed is such a hybrid. This hypothesis is supported

[2] Cytological studies in the genus *Agropyron*. Canad. Jour. Res. **3**: 428–448. 1930.
[3] Size of seed and other criteria of polyploids. Science **88**: 440. 1938.

by the limited distribution, scant seed production, and the frequent presence in the giant plants of short rhizomes which occur only rarely in *A. spicatum*. That the gigantism may be an extreme case of hybrid vigor, however, seems extremely improbable. *A. repens* is the only 42-chromosome member of the genus believed to be present in the locality. Fertilization of 7-chromosome *A. spicatum* eggs by 21-chromosome pollen of *A. repens* or vice versa would result in a hybrid with 28 chromosomes, but it seems hardly possible that such a hybrid would possess only one important characteristic of *A. repens*, namely the presence of more vigorous rhizomes, while all other parts, though larger, were distinctly and unmistakably those of the other parent.

In considering the lack of definite evidence for hybridization as compared with the occurrence of distinctly tetraploid morphological characters and the double number of chromosomes, it seems most likely that this giant wheatgrass is a tetraploid form of *A. spicatum*.

U. S. Department of Agriculture, Forest Service
Ogden, Utah

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 438–441 JUNE, 1942

A NEW GENUS OF RUBIACEAE FROM MEXICO

MAXIMINO MARTÍNEZ

In September, 1941, Miss Marian Storm, author and enthusiastic admirer of the Mexican flora, brought to my attention a shrub which grew in the region of Uruapan, Michoacán. This plant, with its brilliant scarlet-red flowers has long been a favorite of the people of the region and is locally known as *Ayuque*. Because of the condition of the original material, no satisfactory identification of it could be made. A former student of mine, Sr. Emilio Zamudio, was therefore commissioned to collect material sufficient for its further study. The specimens were refractory and did not yield characteristic examples with the usual methods of preparation. As a consequence, it was necessary to devise special techniques for their preservation. Ample material, preserved in formalin, was also made available.

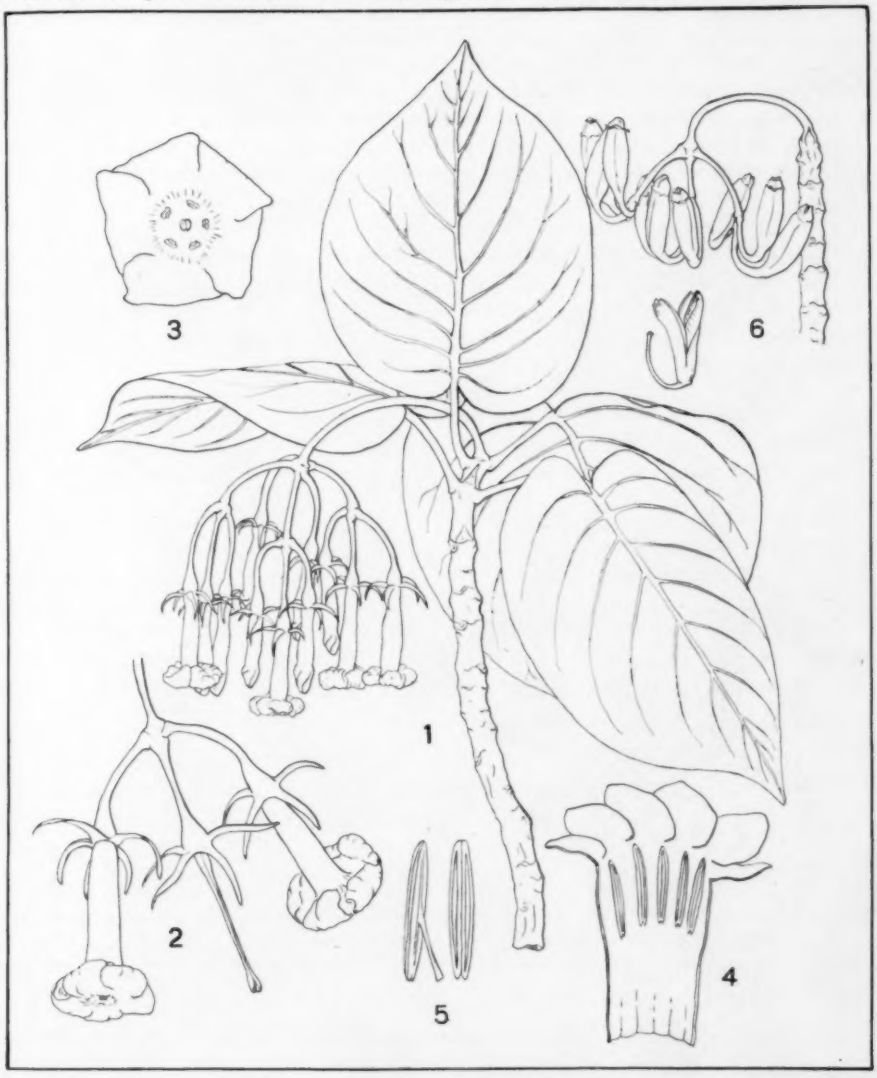
Collections of both flowering and fruiting material, made over a period of several months, lead me to the conclusion that the *Ayuque* represents not only a hitherto undescribed species but also a new genus of the Rubiaceae, closely related to *Cosmibuena* and *Blepharidium*. The following new genus and species are therefore proposed:

Balmea Martinez, gen. nov. Flores penduli; sepala 5, lobis linearibus, subpersistentibus; corollae tubus fere cylindricus, lobis ovatis; stamina infra faucem corollae inserta, filamentis planis, antheris dorsifixis, fusiformibus; capsula erecta; seminis ala indivisa.

TYPUS: species una mexicana, *Balmea stormae*.

Balmea stormae Martinez, sp. nov. Frutex omnino glaber, 5 (4–7) m. altus, ramis ascendentibus, basi 15–20 cm. diam.; lignum fere albidum, cortice 5–10 mm., epidermide chartacea, lutescenti, paullo violacea; ramuli tortuosi, glabri, fulgentes, cinerascentes; folia petiolata, opposita, apice ramulorum conferta, stipulata, crassiuscula, fulgida, flexibilis, siccitate opaca, aspera, laevis; lamina foliorum ovata, apice breviter acuminata, base rotundata vel plus minusve late cordata, 9–13 cm. longa, 6.5–11 cm. lata, integra, utrinque glabra; petiolus 2.5–4 cm. longus, supra canaliculatus, ruber, subtus convexus, viridis, tandem violaceus; nervi claro virides, interdum rubro-violacei, basi subtus subelevati; stipulae interpetiolares, ovato-acuminatae, crassiusculae, interdum papyraceae, caducae, 10 mm. longae; inflorescentia terminalis, cymosocorymbosa, pendula, laxa, multiflora (usque ad 13-flora), trifurcata vel bifurcata, pedunculo communi 5.5 cm. longo; flores hermaphroditi, nocte fragrantes; corollae tubus fere cylindricus, glaber, 22–28 mm. longus, basi leviter attenuatus, rubro-coccineus, dein purpureus, limbo 5-fido, stricte contorto, lobis ovatis vel rotundatis, reflexis, 10 mm. longis; sepala 5, linearia, expansa, luteo-viridia, subpersistentia; stamina 5, cum corollae lobis alternantia, antheris biloculares, subsessilibus, introrsis, longitudinaliter dehiscentibus, filamentis liberis, brevibus, planis, 4 mm.

longis; ovarium oblongum, inferum, biloculare, sepalis coronatum, ovulis numerosis; stylus crassiusculus, glaber, rubro-violaceus, 20–23 mm. longus, 2-sulcatus, apice clavatus, bifidus; capsula ovali-oblonga, bisulcata, bival-



FIGS. 1–6. *Balmea stormae*. FIG. 1. Flowering branch. FIGS. 2, 3, 4. Corolla. FIG. 5. Stamens. FIG. 6. Fruit.

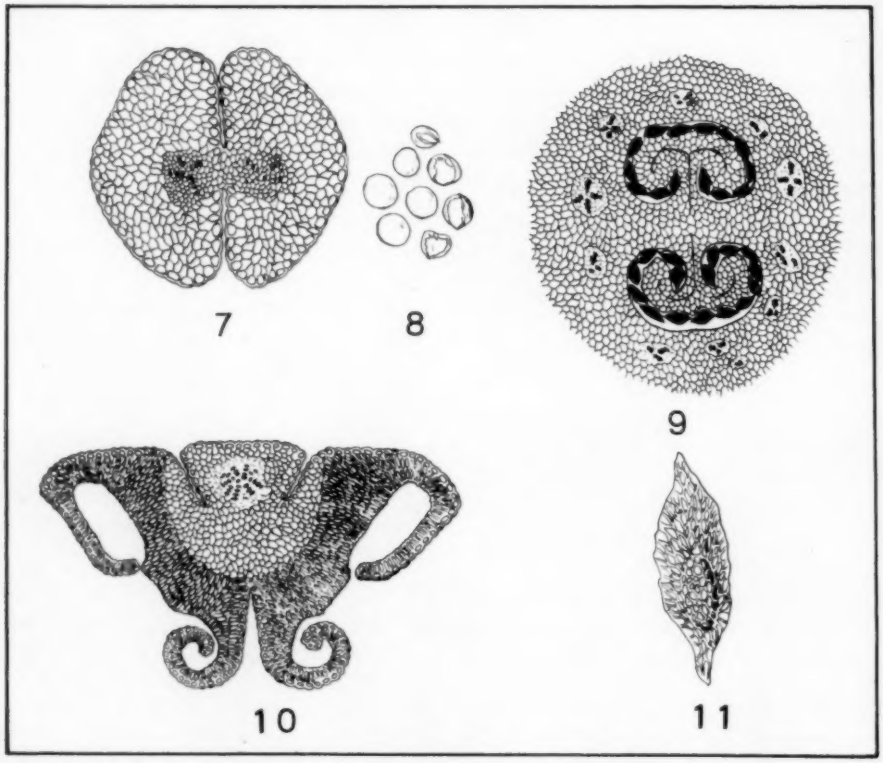
vata, chartacea, junior pendula, maturitate erecta; placentae longitudinales, 2-lamellatae, septo adnatae; semina numerosa, parva, ascendentia, imbricata, alata, ala reticulata, indivisa, 3.5–4 mm. longa.

Floret Augustus–October; semina matura in Decembri vidi.

Habitat in Palo Verde, Pedregales de Jicalán et San Pedro, prope Uruapan, MICHOACÁN, MEXICO.

Typus (*Martínez 3400*) in Herb. Instituto de Biologia, Mexico; Isotypi in Herb. Smithsonian Inst., Gray, Field Mus., Arnold Arboretum, Missouri Bot. Gard., New York Bot. Gard., Univer. Calif., Kew.

A shrub 4–7 meters high, glabrous throughout, branched from below, the individual stems basally 15–20 cm. in diam. Bark smooth, 5–10 mm. thick, greenish purple, peeling off in irregular thin shreds; wood hard, whitish. Branchlets irregular, grayish, sublustrous, showing very clearly the marks



FIGS. 7–11. *Balmea stormae*. FIG. 7. Cross section of the style. FIG. 8. Pollen. FIG. 9. Cross section of the interior of the ovary. FIG. 10. Cross section of the anther. FIG. 11. Seed.

of the petioles. Leaves clustered at the ends of the branches, petiolate, stipulate, opposite, broadly ovate and shortly acuminate, the base obtuse or slightly cordate, entire and deciduous, somewhat fleshy, smooth and flexible, light green and lustrous, the nerves slightly prominent only at the base and underneath, the blade 9–13 cm. long, 6–11 cm. wide, the petiole canaliculate above, where it is red or purple, below convex and greenish; when the weather is exceptionally dry the color spreads to the whole petiole and to the nerves. When dry the leaves turn dull, thinner and somewhat rough. Stipules interpetiolate, triangular, acutish, reddish, slightly fleshy when young,

papyraceous and yellowish when old, 10 mm. long, caducous with the growth of the leaves, leaving a clear mark on the branchlet. Inflorescence terminal, in corymbose cymes, pendulous, in groups of 9–13 flowers, the main peduncle bi- or trifurcate. After the corollas fall and with the ripening of the fruit, the pedicels twist upwards and the capsules remain erect. The common peduncle is 5–5 cm. long and the pedicels 2 cm. long.

Flowers hermaphrodite, gamopetalous, scarlet-red, tinged with purple and, when fully open, dark purple. They are sweet-scented at night. Calyx with 5 linear sepals, yellowish or greenish, 8–10 mm. long, persisting some time after the falling of the corolla. Corolla soon deciduous, its tube 22–28 mm. long, subcylindric, a little narrowed at the base, at first red but soon turning purplish; lobes 5, subovate, entire, imbricate, overlapping to the right (when the lobes open they become reflexed and the overlapping appears to be to the left). Stamens 5, alternate, inserted near the mouth of the tube. Anthers fusiform, 9–10 mm., included, the tips visible but not exerted, bilocular and valvate. Filaments short and flat, 4 mm. long. Style the same color as the corolla, 20–23 mm. long, marked with two opposite furrows. Stigma bilamellate. Ovary inferior, oblong, marked on each side with a suture, bilocular, with the placenta adnate to the septum; ovules numerous. Capsule erect, oval-oblong, 23–28 mm. long, opening at the apex in two follicle-like portions; epicarp papyraceous; seeds numerous, imbricated lengthwise, with a reticulate wing 3.5–4 mm. long.

The shrub flowers from August to October and the capsules are ripe from December to January. Habitat in Palo Verde, the Pedregales de Jicalán and San Pedro, near Uruapan, Michoacán; in dry stony places.

The genus is named in honor of Professor Juan Balme, able student of ornamental plants (to which the *Ayuque* is certainly an addition), and the species in honor of Miss Marian Storm, an enthusiastic collaborator in various of my botanical works.

I also wish to express my appreciation for kind assistance to Dr. F. Miranda, P. C. Standley, C. V. Morton and to Sr. Manuel Ornelas C. to whom I am indebted for the illustrations.

Morelia 61
Mexico, D. F.

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 442–444 JUNE, 1942

A NEW GENUS OF THE ANACARDIACEAE FROM COLOMBIA[1]

FRED A. BARKLEY

The author is indebted to Dr. E. P. Killip for the specimen on which this genus is based. It was sent with the notation that it might prove to be a new genus and this was borne out by a study of the specimen.

This tree grows in the dense forests in the mountains of Colombia. The pith is thick, similar to that of *Rhus*. The branches are densely puberulent, as are the leaves and inflorescences. The flowers have five persistent sepals, five caducous petals, five stamens, a prominent disk, and a tricarpellary pistil. The fruit is outstanding, being a samara-like drupe remindful of *Pseudosmodingium* but bearing long violet-colored hairs similar to that of the fruit of *Actinocheita*, but limited to the margins of the fruit much as in *Heliocarpus*.

It is known only from the type collection.

Ochoterenaea[2] Barkley, gen. nov. Arbor; ramis crassis; foliis imparipinnatis; floribus multis in thyrsis ad terminos ramorum brevium lateralium; sepalis 5 persistentibus, petalis staminibusque 5, pistillo tricarpellato, carpello unico fertili; fructu planissimo, drupa, glabro margine longe pilosa excepta.

Tree; leaves imparipinnate; flowers many in thyrsi at the ends of short lateral branches; sepals 5 persistent, petals and stamens 5, disk prominent, pistil tricarpellary with one fertile carpel; fruit a very flattened drupe long-pilose along the margin.

TYPE SPECIES: **Ochoterenaea colombiana** Barkley, sp. nov. Arbor ad 20 m.; ramis crassis; foliis imparipinnatis, foliolis 11–13, lanceolatis, integerrimis; ramis, foliis, thyrsisque pubescentibus; floribus multis in thyrsis ad terminos ramorum brevium lateralium; sepalis 5 persistentibus, petalis staminibusque 5, pistillo tricarpellato, carpello unico fertili; fructu planissimo drupa, glabro margine longe pilosa excepta.

Tree to 20 meters; branches thick; leaves about 45 cm. long, imparipinnate with 11–13 leaflets; leaflets entire, lanceolate, 11–18 cm. long, 4.5–6 cm. broad; branches, leaves and inflorescence densely puberulent; flowers many in thyrsi at the ends of short lateral branches; sepals 5, persistent, deltoid-ovate; petals 5, caducous, lanceolate; stamens 5; pistil tricarpellary with two abortive carpels; fruit a much flattened drupe, glabrous except for a region on and near the margin which is long pilose with violet hairs and except for a very few glandular hairs mostly limited to the margin.

TYPE: *Killip 34772*, dense forest, Rio Digua Valley, between La Elsa and Rio Blanco, department El Valle, Colombia, altitude 725 meters, April 2–5, 1939, in U. S. National Herbarium No. 1771563.

[1] The author wishes to acknowledge assistance from grants from the Penrose fund by the Research Committee of the American Philosophical Society in his studies on the Anacardiaceae, of which this is a part.

[2] Named in honor of Dr. I. Ochoterena, Director of the Biological Institute of Mexico.

FIG. 1. Type specimen of *Ochoterenaea colombiana* Barkley.

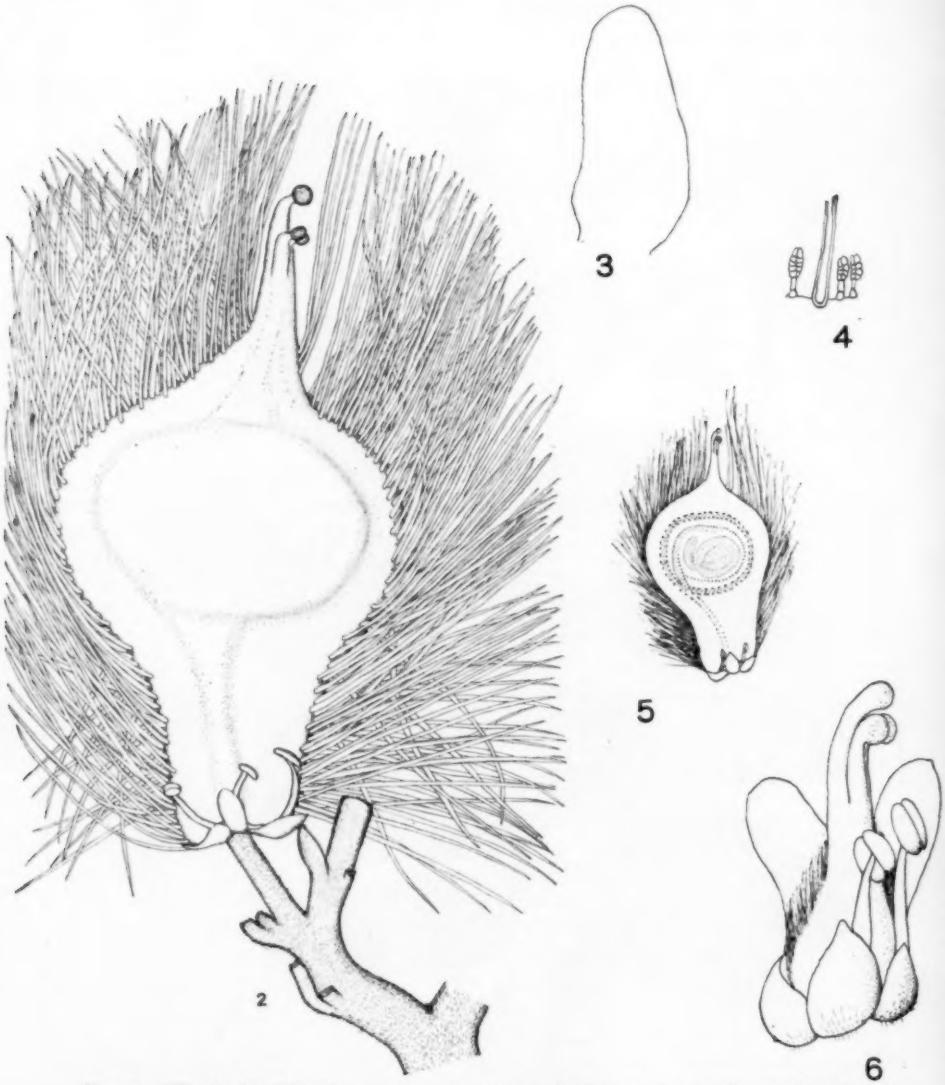


FIG. 2. The fruit of *Ochoterenaea colombiana* with the upper portion of the flowering branch. Note bract scars, persistent sepals, prominent disk, and the marginal position of the pubescence. ×9. FIG. 3. A petal from *O. colombiana*. ×18. FIG. 4. A portion of the margin of the fruit showing glandular hairs. ×120. FIG. 5. Dissection of the fruit of *O. colombiana* showing the endocarp, and orientation of the ovule and embryo. ×4. FIG. 6. A flower of *O. colombiana* with three petals and three stamens removed. ×18.

Specimens are deposited or will be distributed as follows: Ciencias Naturales, Bogota; British Museum, London; U. S. National Herbarium, Washington (two sheets); and in the author's Herbarium.

DEPARTMENT OF BOTANY, MONTANA STATE UNIVERSITY
MISSOULA, MONTANA

BULLETIN OF THE TORREY BOTANICAL CLUB
69(6): 445–460 JUNE, 1942

NEW AND CRITICAL EUPHORBIACEAE CHIEFLY FROM THE SOUTHEASTERN UNITED STATES

LEON CROIZAT

Three new species of *Croton* L. and one of *Manihot* Mill. are recorded in this paper for the flora of south-western Texas. A fourth species of *Croton* L. is described from Sonora, Mexico. Lastly, a summary review is given of *Tetracoccus* Parry under which are published three new subgenera and two new combinations. The Latin diagnoses required for these publications are contained in an appendix at the end of this contribution.

CROTON L.

Croton parksii Croizat, sp. nov. A shrub, apparently dioecious. *Innovations* stellate-tomentose, dull yellow to olivish, tardily glabrescent. *Leaves* reminiscent of the foliage of *C. capitatus* Michx., 2.5–6 cm. long, 1–2 cm. broad, tomentose throughout, grayish underneath, olivish to brownish above, mostly elliptic, more or less short-rounded at the tip, rounded at the base, with about 6–8 pairs of ascending primaries; petiole not over 1 cm. long, slender, tomentose, glands at the lower face of the blade near the insertion of the petiole 2, inconspicuous, basal stipules obscure. *Inflorescence* of coarctate terminal and lateral thickly flowered axes, the ♂ subspicate, sometimes tending to be racemose, the ♀ capitate. *Perianth* ♂ about 8 mm. wide, tomentose, delicate, on a pedicel not over 2 mm. long; petals none; lobes (sepals) 6, sometimes 5, ovate to obovate, about 3 mm. long, 2 mm. wide, heavily ciliate-lanulose, thinly venulose toward the center and there greenish; androecium of about 10–15 stamens inclosed within a disc of 5 conspicuous glands each approximately set at the base of a lobe. *Perianth* ♀ about 5 mm. wide, becoming about 10 mm. wide under a young fruit, tomentose except at the disc and often at the inner face of the lobes, pedicel stoutish about 2 mm. long; petals none; lobes not delicate, triangular-elliptic, about 2 mm. long; disc thin, shallowly cup-shaped under the ovary and slightly broader than it; ovary at first appearing heavily tomentose, soon developing scattered and conspicuous submuricate processes on the epicarp, these heavily coated with whitish stellate tomentum, about 2–3 mm. large in anthesis; styles 3, free, each 2 mm. long, somewhat irregularly 2–3 times cleft, the stylar laciniae forming together a closely matted and involute cluster partly immersed within the thick tomentum of the epicarp, somewhat carnose and brownish where free; fruit capsular, 3-coccous, about 8–9 mm. long and as many broad, globose; seed more or less globular, large for a species in this affinity, about 7 mm. long, 6 mm. broad, the caruncle contiguous with the hilum and produced into a short process just above it, broadly spreading to cover the entire upper end of the seed, the aril smoothish, coarsely mottled by spots and streaks of black and whitish on a background of brown and hazel hues, the raphe thin but conspicuous, the chalaza located on the ventral face of the testa within a small depression, the testa (scraped free from the aril) apparently smooth; columella after dehiscence about 7 mm. long, trans-

versely expanded to about 4 mm.; dehisced cells about 9 mm. long, the endocarp firm, horny, the epicarp fairly thin, finely veined at the inner side when free from the endocarp.

HOLOTYPE: *H. B. Parks s.n.*, Sutherland Springs, Texas, Oct. 1936 (♀ specimen). Flowers ♂ described from *H. B. Parks s.n.*, same locality and date (Gray Herbarium).

The following collections belong here: (1) *H. B. Parks s.n.*, Ingleside, San Patricio Co., Texas, Oct. 1936; (2) *H. B. Parks s.n.*, Flour Bluff, Nueces Co., Texas, Oct. 1936; (3) *V. L. Cory s.n.*, Padre Island 26 miles south of Port Aransas, Texas, Nov. 1940.

A strong species easily distinguished from every other in its affinity but nearest to *C. texensis* Muell.-Arg., from which it differs in the larger capsule and seed, in the outstanding murication of the epicarp, in the more heavily tomentose leaves. Specimens past fruiting are identified by the stoutness and breadth of the columella. *Croton muricatus* Nutt., as shown by the classic specimens in the herbarium of the New York Botanical Garden, is not this species but a synonym of *C. texensis*.

Croton parksii belongs to *Croton* sect. *Drepadenium* Muell.-Arg., which is one of the few natural groups in the classification of *Croton* as treated by Mueller. The distribution of this section has unusual interest. Its type, *C. punctatus* Jacq., ranges from Venezuela to Virginia as a plant of the sea-shore. Other species (*C. texensis* Muell.-Arg., *C. californicus* Muell.-Arg. and the segregates in its vicinity, *C. neomexicanus* Muell.-Arg., *C. gracilis* H.B.K., *C. luteo-virens* Woot. & Standl., *C. parksii* Croiz.) range inland from Texas to northern Mexico and California. This distribution suggests that the ancestral forms in this complex were plants of the shore, as *C. punctatus* still is, which speciated adapting themselves to changed surroundings when the waters withdrew or evaporated in land-locked basins in parts of the ancestral range. The background of this evolution is almost certainly Tertiary if not early Tertiary, there being no lack of evidence that the generic lines of the Euphorbiaceae were drawn at the closing of the Cretaceous. Distributions and speciations of the same order as those characteristic of the *C. punctatus* group are in evidence among certain euphorbiaceous aggregates in Argentina and Central Asia.

Croton coryi Croizat, sp. nov. A shrubby perennial. *Innovations* thickly and coarsely hispid-tomentose, grayish to olivish, tardily glabrescent. *Leaves* verticillate at the apex of the branchlets, 3.5–5 cm. long, 1.5–2 cm. broad, elliptic-lanceolate, round-acuminate at the tip, rounded to subtruncate at the base, coarsely tomentose to hispid-pannose, olive nearly the same on both faces, with about 7–8 pairs of sharply ascending primaries scarcely visible under the indumentum; petiole 1.5–2.5 cm. long, hispid, glands apparently none. *Inflorescences* about 4–6 cm. long, ♂ spicate, ♀ capitulate, with a central spicate axis ♂ and apparently past bloom when the ♀ flowers enter anthesis. *Perianth* ♂ delicate on a pedicel about 3 mm. long; petals ligulate,

hyaline, about 3 mm. long and wide; lobes (sepals) triangular-lanceolate or elliptic-lanceolate, about 3 mm. long and 1.5 mm. wide; androecium of about 15 stamens, the filament 4 mm. long, the anthers about 0.75 mm. long; glands usually 3, irregularly arranged, alternating with or opposing the lobes. *Perianth* ♀ very delicate, hyaline in texture; petals none; lobes 5 apparently fairly even, ligulate to sublinear, entire, with a thin thickened green midrib, about 7 mm. × 1 mm., becoming connate at base into the cup of the perianth, this sometimes bearing processes between the lobes; disc very thin, inconspicuous; ovary about 4–5 mm. large, somewhat ovoid-truncate, the endocarp slightly carinate at the upper end of the keel; styles 3, free, about 2 mm. long, each twice cleft, softly villous; seed about 3 mm. × 2 mm., ovoid, pointed at the upper end, the aril smooth, brownish with blackish and whitish irregular mottlings more numerous on the dorsal than on the ventral face, the caruncle apical, grayish, arrow-shaped, cleft in front.

HOLOTYPE: *V. L. Cory s.n.*, Padre Island, 26 mi. south of Port Aransas, November 1940 (Arnold Arbor.).

This is one of the peculiar endemics of Southwestern Texas. I am unable to state at this time which are its nearest affinities. Although it suggests *C. capitatus* Michx. in the details of its perianths it has a seed unlike any known to me in the species of the *C. capitatus* affinity. It appears likely that the 3 glands of the ♂ perianth are abortive stamens, their vasculation bearing to that of the subtending petal or lobe a relationship similar to that between an enation and the laminar body (petal or leaf) from which it arises. This disposition suggests that the ♂ perianth is undergoing regression, the outer stamens and their immediate appendages tending to fuse more or less irregularly and to depart from the normal quinary actinomorphic pattern of symmetry. A like process of degeneration is evident in the staminate flower of *C. parksii*, being manifested in this flower by the total elimination of the petals and by the more or less variable number of the lobes. The irregularly 6–8-lobed ♀ perianth of the species in the affinity of *C. capitatus* is probably a highly derivative structure arising by the fusion and subsequent reduction of the two normal perianth whorls (calyx and corolla); its peculiarities are strongly reminiscent of the ♀ perianth of *Julocroton*.

Croton albinoides (Ferg.) Croizat, comb. nov. *Croton engelmanni* var. *albinoides* Ferguson, Mo. Bot. Gard. Rept. **12**: 55. 1901.

Ferguson's *C. engelmanni* is invalid under the International Rules of Nomenclature, and must be replaced by *C. lindheimeri* (Engelm. & A. Gray) Wood, based upon *Pilinophytum lindheimeri*. Ferguson credits *C. lindheimeri* in his synonymy to Wood, Class Book of Botany, 631. 1865. This is an oversight; *C. lindheimeri* was used by Wood four years earlier in Class-Book Bot., 631. 1861.

Thanks to the friendly interest of Prof. J. M. Greenman I have had the privilege of inspecting the classic material now preserved in the herbarium of the Missouri Botanical Garden upon which Ferguson established his

understanding of *C. capitatus*, *C. engelmanni*, and *C. engelmanni* var. *albinoides*. Many of these specimens are duplicated in the Gray Herbarium, where I have also seen them. I believe that Ferguson is correct in treating *C. lindheimeri* as a species distinct from *C. capitatus*. These two entities differ both in intangibles and in characters and can be recognized without much difficulty by anyone who has learned how to identify them. The fact that it is often difficult, occasionally impossible, to determine *imperfect* specimens may not be assumed as a justification for treating these two species as one.

I find myself in disagreement with Ferguson, however, when he attaches his var. *albinoides* to *C. lindheimeri*, and this for the very cogent reason that the alleged variety differs as much from *C. capitatus* as it does from *C. lindheimeri*. Ferguson at one time recognized this, too, for he penned a note upon the sheet of *Heller 1800* in the Gray Herbarium to the effect that "This is typical of a very broad leaf form from S.W. Texas that shares characters from *C. capitatus* and *C. engelmanni*. It might form a subvariety under either. Ferguson Dec. 1897." It stands to reason that if a form is the connecting link between two others but cannot be brought under either on account of its strong individuality, either three separate species are involved in the complex or only one with two subordinate trinomials: both taxonomy and logic militate against two species with one variety being recognized in this case.

Ferguson's assumption that two species and one variety are involved rather than three species can easily be tested studying as a whole the group to which belong *C. capitatus* and *C. lindheimeri*. Leaving *C. albinoides* out of the reckoning, the species in this group are at least four—*C. capitatus* Michx., *C. lindheimeri* Wood, *C. muelleri* Coult., and *C. elliottii* Chapm. Of these four entities *C. elliottii* is the one that stands out most sharply despite the fact that it occasionally resembles depauperate specimens of *C. capitatus*. The affinities of *C. elliottii* lie in the immediate vicinity of *C. tenuilobus* S. Wats. (Mexico), *C. pedicellatus* H.B.K. (Colombia, Ecuador, Peru), *C. andinus* Muell.-Arg. (Bolivia, Argentina), and their allies in Paraguay and Brazil. Accordingly it would seem probable that the *C. capitatus* group has had its geographic and phylogenetic cradle in a geologic region now represented by southwestern Texas and that its affinities are to be sought with an Andine, i.e., prevailingly alpine element of tropical American flora. This, as we have already seen, is not the case with the group of *C. punctatus*, which is essentially Carribean and appears to have speciated from ancestral forms living along the strands of seas and other bodies of water. The fact that, as Ferguson notes, *C. albinoides* shares its range with *C. lindheimeri* but does not intergrade with it is characteristic of an entity that is already individualized and stable. Considering that Pleistocenic segregates of the

Euphorbiaceae in Argentina and in Europe are less stable in their morphology than *C. albinoides* (witness the polymorphism of the *Euphorbia portulacoides* and *Euphorbia esula* groups), there is ample justification on general grounds for interpreting this *Croton* as better than an occasional variety.

It is commonly understood that the seed furnishes the best characters of taxonomic and systematic determination in the Euphorbiaceae. Within certain limits I believe this to be true, especially in *Croton*. Whenever seeds are compared, however, a sharp distinction should be made between the aril and the testa, which recently (in Darwiniana **5**: 449. 1941) I have had reason to emphasize. The aril and its appendage, the caruncle, are not laid down and fully formed until the seed is ripe. The thickness and color of the aril, especially, vary during the evolution of the seed to maturity; unripe seeds have thin arils through which the testa is apt to show, but ripe seed may be so thickly coated by the aril so as not to show the testa at all. It also happens that plants grown under the best conditions may have slightly larger seeds than depauperate specimens; the aril itself may be thicker in response to edaphic conditions, it being likely that the more xerophilous members of an aggregate have thicker arils. I have unfortunately failed to secure fully ripe seed of *C. muelleri* but I have seen good seeds of *C. capitatus*, *C. lindheimeri*, and *C. albinoides*. Laid side by side the seeds of these four entities form a perfect series, as follows. (1) *C. capitatus:* seed lenticular, 5 mm. long and 5 mm. broad; aril thick, testa smoothish covered by the aril throughout. (2) *C. lindheimeri:* seed sublenticular, 4.5 mm. long and about 4 mm. broad; aril not very thick, testa finely rugulose-lacunose showing through the aril. (3) *C. albinoides:* seed ellipsoid, 4 mm. long and about 3 mm. broad; aril not very thick, testa rugulose-lacunose showing through the aril. (4) *C. muelleri:* seed nearly ripe and probably not materially different from a ripe seed, ellipsoid, 3 mm. long and 2.5 mm. broad; aril not very thick, testa as in *C. albinoides*. These four seeds are illustrated in figure 1 a, b, c, d, which should be compared with Ferguson's illustrations of the seed of *C. capitatus* (op. cit., pl. 18, 5), *C. lindheimeri* (as *C. engelmanni*, op. cit., pl. 19, 6), and *C. muelleri* (op. cit., pl. 20, 3). Clearly, the characters of these seeds are such that there is as much reason to treat *C. muelleri* as a variety of *C. albinoides* as there is for reducing *C. albinoides* trinomially under *C. lindheimeri*. Each of these seeds differs from every other in about the same degree, and taken together they bespeak uniform speciation within a fundamental consanguinity. In conclusion: four species are involved, not three species and one variety.

The evidence furnished by the seed that four species are actually involved is confirmed by other characters. The perianth of *C. lindheimeri* under a capsule about ready to dehisce is approximately 9 mm. long, while

it is fully one-third shorter in a comparable specimen of *C. albinoides* (fig. 1 e, f); the lobes are more or less irregular in *C. lindheimeri* but nearly or quite regular in *C. albinoides* (fig. 1 g, h). The indumentum of the flowers of *C. lindheimeri* has a marked yellowish or orangish cast, while that of

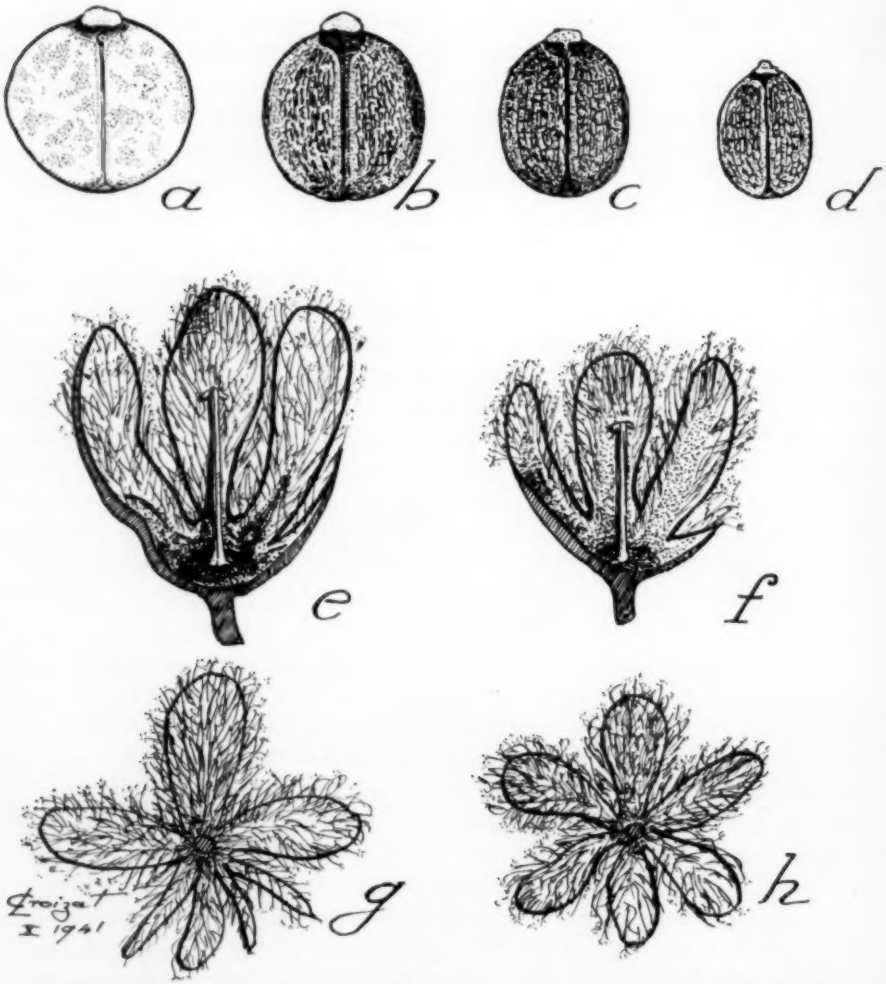


FIG. 1. Seed of (a) *Croton capitatus* Michx.; (b) *C. lindheimeri* Wood; (c) *C. albinoides* Croiz.; (d) *C. muelleri* Coult. A ♀ perianth in fruit of: (e) *C. lindheimeri;* (f) *C. albinoides* (sectioned to show details of the interior). A ♀ perianth in flower of: (g) *C. lindheimeri;* (h) *C. albinoides.* All drawings approximately to scale.

C. albinoides is whitish or grayish; Ferguson, as a matter of fact, uses the color to key *C. lindheimeri* out of *C. albinoides* (op. cit., 37) as follows: "Woolly tomentum of the calyx yellowish. *C. Engelmanni.* Appressed tomen-

tum white. *C. Engelmanni albinoides.*" It is true, moreover, that the tomentum is fluffier in *C. lindheimeri* than in *C. albinoides*, the difference in this respect being readily noticeable both in living and pressed specimens. Ferguson, lastly, establishes a definite separation between *C. lindheimeri* and *C. albinoides* when he states (op. cit., 55–56) that the latter grows with the former "but intermediate forms have not been observed." The range of *C. albinoides* is very pertinently indicated by him as "Southwest Texas and northward," thus localizing the species in southwestern Texas, whence it has radiated northward.

The following collections may be recorded for *C. albinoides*, (1) *Chandler 7075*, Rio Hondo, Cameron Co., Texas, Sept. 1913; (2) *Cory 17059*, 7 miles north of Sarita, Kenedy Co., Texas, Oct. 1935; (3) *Runyon 1985*, Boca Chica, Cameron Co., Texas, Sept. 1938; (4) *Cory s.n.*, Padre Island, 26 miles south of Port Aransas, Kleberg Co., Texas, Nov. 1940 (seeds about 5 mm. long, 4 mm. broad).

Pax & Hoffmann (in Natürl. Pflanzenf. **19**(c) : 87. 1931) put *C. capitatus* Michx., *C. elliottii* Chapm., and *C. berlandieri* Muell.-Arg. under *Croton* subg. *Heptallon* (Raf.) Muell.-Arg. 1865. This listing contains several errors. Overlooking the lesser ones, such as the crediting of *C. berlandieri* to Mueller Argoviensis rather than to Torrey and the crediting of the subgenus to Mueller rather than to Pax himself, I should remark that, if published in 1865 or at any time thereafter, *Croton* subg. *Heptallon* is invalidated by *Croton* subg. *Pilinophytum* (Kl.) A. Gray (Man. Bot., ed. 2, xi, 391. 1856). A discussion of the nomenclature of this group in *the sectional rank* is contributed by Sprague (Kew Bull. **1929**: 82), cited by Pax & Hoffmann.

Croton subjucundus Croizat, sp. nov. Apparently a small shrub. *Innovations* at first thinly gray-tomentulose, very soon glabrous. *Leaves* 3–5 cm. long, 0.5–1.5 cm. broad, rather thin, drying a dark olive-green on both faces, glabrescent, lanceolate, bluntly rounded and mucronate at the tip, cuneate to round-cuneate at the base, with about 9 pairs of primaries, the basal sharply ascending, the next ones above ascending to broadly ascending, margins of the blade entire with few sessile or subsessile glands; petiole very slender, 1–2 cm. long, with a pair of glandular-setaceous stipules at the tip near the insertion of the blade and a tuft of glandular-setaceous stipules on either side at the base. *Inflorescence* a simple bisexual axis, the ♂ part seen only immature, apparently short. *Perianth* ♂ immature, not dissected. *Perianth* ♀ when fully spread out not over 5 mm. broad, the triangular-acuminate lobes not over 2 mm. long, bearing along their entire margin sessile or subsessile glands like those marginal to the leaf; petals as glands, altogether matching those at the apex of the petiole, apparently arising from the thin disc, this of 5 more or less connected glands, each gland opposing a lobe; ovary tomentellous to glabrate, grayish, smooth, globose-ovoid, about 2 mm. long and broad; styles 3, free, each 2–2.5 mm. long, dissected more or less irregularly, usually cleft into three main strips, the 2 lateral subfiliform,

the median one larger and once again dissected into 2 or 3 branches: seed ellipsoid, about 3.5 mm. × 3 mm., 2–3 times shallowly costate, the aril whitish, unevenly spread, filling the grooves and thickly covering the sides of the seed which appear whitish, elsewhere allowing the light-brownish testa to be seen.

HOLOTYPE: *Drouet & Richards 3923*, Navajoa, Sonora, Mexico, Dec. 1939 (Arnold Arbor.).

The holotype was distributed as *C. sonorae*, which is a patent misdetermination. *Croton subjucundus* is allied with *C. jucundus* Brandg. and *C. soliman* Schlect. & Cham., these two species being perhaps too close. I have carefully compared a good specimen of *C. jucundus*, which ranges nearest to *C. subjucundus* in Sonora, with the holotype of my species. *Croton jucundus*, as exemplified by *E. Palmer 1489*, has a ♀ perianth 10 mm. broad, with lobes about 5 mm. long, beset by numerous manifestly pedicelled glands, whereas *C. subjucundus* has a perianth barely 5 mm. broad, with lobes about 2 mm. long, bearing few short pedicelled or sessile glands. The styles of *C. jucundus* are at least three times as long as those of *C. subjucundus*, and its leaves bear at the margin many more long-pedicelled glands. It appears likely that the range of *C. subjucundus* is definitely more northern than those of its allies.

MANIHOT MILL.

Manihot walkerae Croizat, sp. nov. *Manihot carthagenensis*, Muell.-Arg. in DC. Prodr. **15**(2): 1073. 1866, quoad pl. Torrey, non Jacq. *Janipha loeflingii* Torrey in Emory Rept. U. S. Mex. Boundary Surv. **2**: 199. 1859, non H.B.K.

A low more or less scandent shrub. *Innovations* herbaceous, glabrous throughout and finely papillose under the lens when dry. *Leaves* glabrous, greenish above, more or less markedly glaucescent beneath, very variable in shape and size but essentially palmatilobed and peltate, 5–14 cm. long, 4–11 cm. broad; blade normally of 5 lobes around a subcentral peltate part, 1 lobe central, 2 lateral, these giving rise each to 1 lobe or lobule on the adaxial side; *central lobe* 3–7 cm. long, 1–3 cm. broad, ovate-lanceolate at the tip, scarcely mucronate or setulose, constricted 1–4 times more or less deeply at or below the middle, therefore repand pandurate, the lobulets arising by constriction patent, scarcely over 1.5 cm. long; *lateral main lobes* 2–6 cm. long, one occasionally missing, 0.5–3 cm. broad, constricted more or less like the median; *lateral secondary lobes* 2, arising from the lateral main ones, sometimes scarcely more conspicuous than lobulets by constriction, 0.5–3 cm. long, usually neither lobulate nor constricted; petiole slender, firm 3.5–8 cm. long, the stipules setaceous, inconspicuous. *Inflorescence:* the ♂ part a subspicate definite axis, the ♀ flowers practically free from the ♂ axis and basal to it, each flower usually borne upon its own pedicel, this arising directly or almost directly from the stem. *Perianth* ♂ definitely tubular and scarcely inflate at the base, borne on a pedicel not over 3 mm. long, the tube about 9–10 mm. long in anthesis, apparently inconspicuously streaked, the lobes 5, broadly lanceolate, 5–6 mm. long; stamens 10 (as seen; 8 described by Torrey) paired in the axils of lobulate glands, the filament about 8 mm. long, the anthers 2

mm. long. *Perianth* ♀ of lobes free to the base, only seen in a young fruit; lobes about 10 mm. long, 2.5–3 mm. broad, ligulate and rather bluntly acuminate, the disc manifest, bearing a few apparently imperfect stamens, their filaments usually persisting up to the fruit-stage; capsule on a pedicel 1.5–2.5 cm. long, more or less globose, about 12 mm. large, sparingly but manifestly verruculose and rugose, the 6 sutures (3 commissural, 3 dorsal) manifest; seed flattened, about 8 mm. long, 6 mm. broad, smooth, the aril ashen-gray with large blackish spots at the sides of the seed, especially on the dorsal face; caruncle large, 2 mm. long, about 4 mm. broad, yellowish, slightly cleft and 2-lipped in front.

HOLOTYPE: *E. J. Walker* (H. B. Parks) *s.n.*, along the lower Rio Grande, south of Mission, Hidalgo Co., 1940 (in herb. Arnold Arbor.).

The type material was collected by Mrs. E. J. Walker of La Joya and transmitted by Mr. Parks through Mr. Cory. The two sheets of *Schott's* collection at the Ringgold Barracks, 1853, seen by Torrey and identified by him as *Janipha loeflingii* and *Janipha loeflingii* var. *yuquilla* are now preserved in the herbarium of the New York Botanical Garden, bearing Britton's determination, *Manihot carthagenensis* Muell.-Arg. *Janipha loeflingii* is an invalid renaming of *M. carthagenensis*, and *J. yuquilla* is probably little better than a leaf-form of the same species. It appears that Mueller Argoviensis was misled by the erroneous determination of Torrey into bringing the Texan plant into the synonymy of the Colombian *Manihot* where it has remained ever since 1866. That the species are different is clear, the perianth, not to mention other less immediately evident characters, being short and inflated in *M. carthagenensis*, rather narrow and tubular in *M. walkerae*. The resemblance in the foliage is close, however: in certain specimens of *M. carthagenensis* or forms near it (for instance, *Seler 2814*, Guatemala, 1896) the leaf has very much the same aspect and outline of that of the holotype of *M. walkerae* and of Schott's collections. Pax (in Pflanzenr. 44 (iv. 147. ii): 81. 1910) does not list nor mention Texan material under *M. carthagenensis*. Coulter, on the contrary, follows the lead of Mueller (Contr. U. S. Nat. Herb. **2**(3): 400. 1894) and it is on Coulter's authority rather than on that of others that *M. carthagenensis* has erroneously been received in the flora of Texas. *Manihot carthagenensis* is a critical species which it should be desirable to typify as there is no lack of evidence that several species are confused under this binomial in tropical America as well as in Mexico.

In the notes and sketches attached to the Schott specimens Torrey states that the stamens vary from 8 to 10 and mentions that some of them are longer. Whether this is true or not I may not definitely say: I have found only 10 stamens without the appearance of a superimposed verticil in the few flowers which I have dissected. I have now a plant of *M. Walkerae* in cultivation in the hothouse and, should it blossom, it will be possible to verify the constancy of the stamens both in number and in length.

Manihot is a genus of great interest to students of carpellary structures. The vasculation of the epicarp arises mostly *from the columella*, and it streams to the epicarp through peculiar gaps between the so called carpels, this being accurately figured by Baillon (Etud. Gén. Euphorb., pl. xix, 15. 1858). There is, moreover, a very strong indication that abortive stamens may enter in the making of the epicarp of the Euphorbiaceae or, at least, may become intimately adnate with it, nuptial nectaries being found scattered upon the ovary of *Podadenia thwaitesii* Muell.-Arg. and, occasionally, of species of *Codiaeum* A. de Jussieu.

TETRACOCCUS ENGELMANN EX PARRY

Wheeler, I believe, has written the most recent study of *Tetracoccus*. In this review (Contr. Gray Herb. **127**: 50–53. 1939) he eventually concludes that *Tetracoccus* and *Halliophytum* cannot be maintained as separate genera. Unfortunately, this conclusion has no effect, because Wheeler fails to follow it by the reductions and transfers which are required to make it taxonomically viable.

In the course of abundant bibliographical and nomenclatural remarks Wheeler affirms that *Bernardia*(*?*) *fasciculata* S. Wats., the basinym of *Halliophytum fasciculatum* Johnst., is a provisional name to be rejected under Art. 37 *ter* of the International Rules of Nomenclature. There is no reason for me to take up this affirmation and, even less, to comment upon Cook's more recent declarations on the same subject (in Jour. Wash. Acad. **31**: 51. 1941), because I have dealt with *nomina provisoria* on two previous occasions (Jour. Arnold Arb. **21**: 499. 1940; **22**: 137. 1941). Since, however, it is desirable that the already involved nomenclature of *Tetracoccus* should not be again disturbed by misinterpretations of the Rules, I will briefly deal with the concept of "validation" as this may apply to Johnston's use of *Bernardia*(*?*) *fasciculata* as basinym for *Halliophytum fasciculatum*.

The animadversions contributed by Wheeler in the cited review and his later discussion of the meaning and purposes of Art. 69 (Am. Midl. Nat. **21**: 529. 1939) indicate that his understanding of this Article is not altogether clear. Article 69 offers a solution to a fundamental nomenclatural difficulty which is the cleverest to be found in the whole body of the Rules. The author of this solution fully understood that the recognition of the validity of a combination based upon an illegitimate name would conflict with the basic principle (Art. 2) that an illegitimate name *must* be rejected. He realized, on the other hand, that the rejection of combinations already effected around illegitimate names would disturb the stability of nomenclature which is the foremost concern of the Rules (Art. 4). As a way out of this dilemma the author of Art. 69 devised the altogether elegant solution of treating combinations made around illegitimate names as *new names*. To elucidate, using

the example in Art. 69: *Talinum polyandrum* Hook., being illegitimate, could not be accepted as the source of *Calandrinia polyandra* (Hook.) Benth. *comb. nov.* The specific epithet *polyander* could be freely used, however, to propose *Calandrinia polyandra* Benth. *nom. nov*, naturally, so long as no other earlier homonym stood in the way of this binomial. In other words: the author of Art. 69 decided that the use of an illegitimate epithet in a new combination justifies merely a change in authorship, not the rejection of the binomial. Thus he automatically reconciled the stability of nomenclature (Art. 4) with the principle that an illegitimate name must be rejected (Art. 2). That this is a wise and able solution does not need to be emphasized in detail. Fully recognizing the value of the solution offered by the author of Art. 69 Rehder has proposed (Jour. Arnold Arb. **20**: 276. 1939) that this solution be definitely embodied in the text of the Article itself rather than be attached, as it were, to its end. I may add that it should be desirable to extend to trimonials (Art. 58) the principle that a combination based on an illegitimate name is a *new name*. Be this as it may, Johnston had a clear case for publishing *Halliophytum fasciculatum*. This binomial would be treated as a *new name* (Art. 69) in the event that *Bernardia(?) fasciculata* should prove to be illegitimate. It would be treated as a *new combination*, on the contrary, if *Bernardia(?) fasciculata* turned out to be a legitimate binomial. Thus, nothing more relevant can be involved in Wheeler's animadversions and discussions than the fact whether the correct citation is to be *Halliophytum fasciculatum* Johnst. or *H. fasciculatum* (S. Wats.) Johnston. Since there is not the slightest doubt about *Bernardia(?) fasciculata* being a legitimate name and not a *nomen provisorium*, the correct citation is *Halliophytum fasciculatum* (S. Wats.) Johnst., and *Tetracoccus fasciculatus* (S. Wats.) Croizat.

It is true that *Halliophytum* is not separated from *Tetracoccus* by sharp generic distinctions. Very few genera of the Euphorbiaceae, as a matter of fact, are separated from their nearest allies by conventionally "strong" characters, and nothing could be more easily done than to "prove" that *Mallotus* and *Macaranga*, *Andrachne* and *Phyllanthus*, *Chamaesyce* and *Euphorbia*, *Sapium* and *Stillingia* are not all "good" genera. Such a "proof," however, would lead taxonomy nowhere, for it would merely lead to the conclusion that since every genus is another genus and every family merges with some other it is useless to do any taxonomic work at all.

Tetracoccus and *Halliophytum* differ in the details of their foliage, in certain characters of their capsules, and, which is more important, in the arrangement of their inflorescences. If these two genera had been in use for a century they would be kept separate today on grounds of tradition and convenience in the same manner as Hooker maintains *Glochidion* (Fl. Brit. Ind. **5**: 306. 1887) and Prain upholds *Excoecaria* (Fl. Trop. Afr. **6**(1): 1018.

1913). Likewise, if these two genera had each numerous species or occurred in separate regions they would be recognized as are *Andrachne* and *Phyllanthus, Mercurialis* and *Claoxylon*. A very strong case indeed could be made for maintaining *Halliophytum* if the discovery of *Tetracoccus ilicifolius* Cov. & Gilm. had not introduced a new element in our understanding of the range and morphology of this group. We know today what was not as yet known to Johnston when he published *Halliophytum;* the species in this complex are few and fall into three rather than only two main groups. We know, moreover, that the systematic position of this entire aggregate is peculiar. *Tetracoccus ilicifolius* is reminiscent of *Toxicodendron globosum* (Gaertn.) Pax & Hoffm., a monotype of South Africa, of which it practically has the ♂ inflorescence. *Tetracoccus capensis*, on the other hand, suggests the characters of *Securinega virgata* (Poir.) Maire, endemic to Portugal and allied with *S. leucopyrus* Muell.-Arg., from India, and *S. acicularis* Croiz., from Central China. It might be inferred from these affinities that the surviving American and Mexican oligotypes under *Tetracoccus* and *Halliophytum* are relics from an aggregate which was originally far richer in diversified forms than it is at present, and was closely related with forms which today we must accept as unrelated because the connecting links are extinct. Clearly, *Tetracoccus* and *Halliophytum* stand at the threshold of a full generic segregation, and the latter of these two names must be regarded as a subgenus of the other. That *Tetracoccus* is not congeneric with *Securinega* will be evident to anybody who critically studies the two entities.

In agreement with the previous conclusions, I propose the following classification:

Tetracoccus Engelm. ex Parry in West. Am. Scient. **1**: 13. 1885; Pax & Hoffm. in Natürl. Pflanzenf. **19**(c): 74. 1931; Munz, Man. S. Calif. Bot. 282. 1935; McMinn, Man. Calif. Shrubs 252–253, figs. 286–287. 1939; Wheeler in Contr. Gray Herb. **127**: 50–53. 1939.

Bernardia (?) S. Wats. in Proc. Am. Acad. **18**: 153. 1883; Brandeg. in Zoë **4**: 405. 1894. Non Adans.

Securinega, I. M. Johnst. Univ. Calif. Publ. Bot. **7**: 441–442. 1922; Jepson, Man. Fl. Plants. Calif. 593. 1925. Non A. L. de Juss.

Halliophytum I. M. Johnst. Contr. Gray Herb. n.s. **68**: 88. 1923; Munz, op. cit. 283; McMinn, op. cit. 249, fig. 282.

NOMENCLATURAL TYPE: *Tetracoccus dioicus* Parry.

A. **Eutetracoccus** Croizat, subg. nov.

NOMENCLATURAL TYPE of the genus; monotypic.

Inflorescence ♂: cymose racemes, sometimes leafy or bracteate-leafy. Inflorescence ♀: flowers mostly single, peduncles and pedicels elongate, persistent, ultimately woody; capsule hard, sublignescent. Leaves subentire, nearly alternate to alternate or fascicled in clusters of few.

B. **Halliophytum** (Johnst.) Croizat stat. nov.

NOMENCLATURAL TYPE: **Tetracoccus fasciculatus** (S. Wats.) Croiz. comb. nov. (*Bernardia*(?) *fasciculata* S. Wats. Proc. Am. Acad. **18**: 153.

1883; *Halliophytum fasciculatum* Johnst. Contr. Gray Herb. n.s. **68**: 88. 1923.

Two species in addition to the nomenclatural type, (a) *T. hallii* Brandeg. Zoë **5**: 229. 1906; (b) **T. capensis** (Johnst.) Croiz., comb. nov. (*Securinega capensis* Johnst. Univ. Calif. Publ. Bot. **7**: 441. 1922).

Inflorescence ♂: flowers single or few together borne as a rule on brachyblasts. Inflorescence ♀: flowers single or nearly single, peduncles and pedicels delicate or, at least, shorter and smaller than those of Subg. *Eutetracoccus;* capsule small, more or less elongate, firmly coriaceous rather than lignescent. Leaves small, entire, fascicled or congested, alternate.

C. **Tetracoccaster** Croizat, subg. nov.

NOMENCLATURAL TYPE: *Tetracoccus ilicifolius* Cov. & Gilm. in Jour. Wash. Acad. Sc. **26**: 531. 1936. Monotypic.

Inflorescence ♂: racemose or cymose, elongate, the flowers reduced and subglomerulate along a main axis. Inflorescence ♀: like that of *Eutetracoccus.* Leaves alternate, subopposite, opposite or verticillate manifestly serrate.

In closing this brief review of *Tetracoccus* I must thank Mr. M. F. Gilman, co-author of *T. ilicifolius,* for his truly inexhaustible patience in supplying me with pressed specimens, live cuttings, and complete flowering and fruiting material of this remarkable species.

LATIN DIAGNOSES

Croton parksii Croiz., sp. nov. Fruticulus; foliis tomentosis, *C. capitatum* Mchx. in mentem vocantibus, plerumque ellipticis, 2.5–6 cm. longis, 1–2 cm. latis, petiolo ad 1 cm. longo. Inflorescentiis abbreviatis subspicatis vel racemosis, in ♀ capitulatis. Perianthio ♂: petalis nullis, lobis 6(–5), staminibus 10–15 intra discum glandulosum impositis, pedicello 2 mm. longo. Perianthio ♀: petalis nullis, lobis triangulari-ellipticis, disco tenui, capsula muricata, tomentosa, ca. 10 mm. magna: semine 7 mm. longo 6 mm. crasso, caruncula valida apicem seminis totius obtegente.

Croton coryi Croiz., sp. nov. Fruticulus, apicibus grosse hispido-tomentosis. Foliis hispido-tomentosis 3.5–5 cm. longis, 1.5–2 cm. latis, ellipticis vel elliptico-lanceolatis; petiolo 1.5–2.5 cm. longo. Inflorescentiis subspicatis vel capitulatis. Flore ♂ delicato, hyalino, petalis sepalisque 5, glandulis ca. 3, staminibus ca. 15. Flore ♀: Perianthio hyalino, lobis 5, ligulatis ad 7 mm. longis, petalis nullis, disco obscuro, ovario 4–5 mm. magno, stylis 3 liberis ca. 2 mm. longis; semine acutato, brunneo-griseo, levi, caruncula apicali sagittata.

Croton subjucundus Croiz., sp. nov. Fruticulus, apicibus griseo-tomentellis dein glabratis. Foliis lanceolatis 3–5 cm. longis, 0.5–1.5 cm. latis, apice abrupte rotundato-mucronatis margine glandulis sessilibus vel subsessilibus paucis obsito, venis ca. 9-jugis, petiolo gracili, apice glandulis binis, basi glandulis plurimis totis setaceo-glandulosis obsito. Flore ♂ haud viso. Flore ♀: perianthio 5 mm. lato, lobis triangularibus ad 2 mm. longis, petalis glandulosis; ovario ca. 2 mm. magno, stylis 3 liberis 2–2.5 mm. longis, in lacinias dissectis: semine ellipsoideo, grosse costato, arillo tenuiore, albicante.

Manihot walkerae Croiz., sp. nov. Frutex plus minusve scandens, innovationibus herbaceis. Foliis 5–14 cm. longis, 4–11 cm. latis, mire ludentibus,

pro more palmatim 5-lobis, peltatis, lobis constrictis vel panduratis. Inflorescentia racemosa, basi ♀. Perianthio ♂: tubulari apice 5-lobato, haud inflato, ca. 10 mm. longo, 12–16 mm. lato, staminibus ca. 10, binis in axilla glandulae retusae. Perianthio ♀: ad basim partito, 5-lobo, lobis ca. 10 mm. longis sub fructu immaturo: disco staminibus paucis onusto: capsula verruculosa, 12 mm. magna, globosa: semine lenticulari 8 mm. longo, 6 mm. lato, arillo cinereo, maculis nigris praesertim ad latera dorsumque notato.

Eutetracoccus Croiz., subg. nov. Inflorescentia ♂: racemis cymosis, interdum foliosis vel bracteato-foliosis. Inflorescentia ♀: floribus plerumque singulis, pedunculis pedicellis elongatis, lignescentibus, persistentibus; capsula dura, lignescente. Foliis subintegris, subalternis vel alternis vel paucis fasciculatis.

Tetracoccaster Croiz., subg. nov. Inflorescentia ♂: racemosa vel cymosa, elongata, floribus diminutis, secum rachidem subglomeratis. Inflorescentia ♀: cum illa *Eutetracocci* congruente. Foliis denticulatis, ilicinis.

ARNOLD ARBORETUM, HARVARD UNIVERSITY
JAMAICA PLAIN, MASSACHUSETTS

NOTE: This paper had been typewritten and sent to the editor, when I received from Mr. C. T. White, of the Botanic Gardens of Brisbane, Queensland, Australia, seeds of *Petalostigma glabrescens*, which I had requested a long time ago to effect a comparison with the seeds of *Tetracoccus*.

Both the seed of *Petalostigma* and *Tetracoccus* have a glossy vitreous aril, flesh-colored in the former, nearly brick-colored in the latter, which is immediately recognized by those who have once seen it. An evolute caruncle also occurs in both genera, the micropyle being reached through a more or less tubular opening in the caruncular tissues or folds. The raphe is external, that is, it runs through the aril, close to the testa but not within the testa, as it does in other Euphorbiaceae, nor under it. The chalaza is fairly well marked or well marked, the chalazal vascular plug being manifest. The differences between the seed of *Petalostigma* and *Tetracoccus*, exemplified, respectively, by *P. glabrescens* and *T. ilicifolius* are on the whole of little moment. In the former, which is about 8–9 mm. long, the micropylar end of the testa is produced into a thin point, the radicle being practically vertical in relation to the longer axis of the seed; in the latter, 4–5 mm. long, the radicle is slightly deflexed, and a considerable thinning out of the testa takes place under the caruncle. The endosperm is about of the same amount, texture and color in the two species.

The seed of *Securinega virosa* (*Flueggea virosa*) departs from the seed of *T. ilicifolius* in the lack of the caruncle and in minor structural details, but agrees in other respects, such as in the presence of an endosperm. A logical interpretation of these three seeds is that the ancestral form is that of *Petalostigma*, the seed of *Tetracoccus* being intermediate between that of *Petalostigma* and *Securinega*. In many respects, *Petalostigma* is strongly

reminiscent of *Beyeria* and *Ricinocarpus*, forming with them a group which it is possible to tie in phylogeny with the Sterculiaceae of the *Keraudrenia—Seringia* affinity in a very conclusive manner.

Since these Sterculiaceae are also very near the probable ancestors of *Croton* it is possible to visualize the following lines of descent: The ancestral sterculioid form, derived from the malvoid plexus by a definite fixation of the tendency towards apetaly and unisexuality first appearing in certain

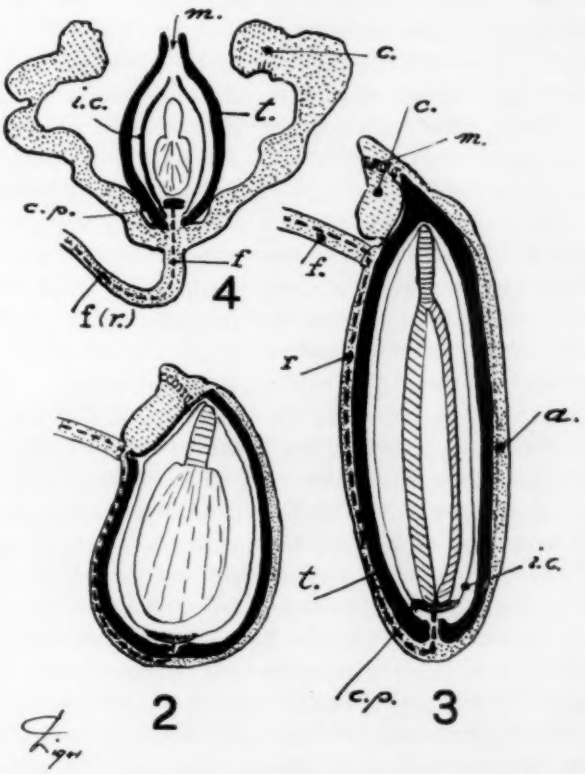


FIG. 2. Section through seed of *Tetracoccus ilicifolius*. FIG. 3. Section through seed of *Petalostigma glabrescens*. FIG. 4. Diagram of ancestral ovule. For explanation see text.

Malvaceae, yields two main streams of evolution, one that moves towards the *Croton* aggregate, the other towards the *Phyllanthus* group. At the point of common origin of these two streams are found *Ricinocarpus, Beyeria, Longetia, Toxicodendron* and *Petalostigma*. Moving further in the direction of *Phyllanthus* we see *Putranijva* and *Drypetes* appear together with *Tetracoccus*. Next comes *Securinega* and last *Phyllanthus*, the largest and the most polymorphous of all the genera mentioned. These conclusions substantially

agree with those advanced in the previous article to the effect that *Tetracoccus* is a relic from a group that is less advanced than *Phyllanthus* but as yet not too far from, and possibly earlier than *Securinega*.

Figures 2–4 illustrate a section through the seed of *Tetracoccus ilicifolius* (fig. 2) and *Petalostigma glabrescens* (fig. 3). The fibro-vascular system of the funiculus (f) furnishes the raphe (r), which runs within the aril (a) and enters the chalaza at the base of the seed passing through an evident opening in the testa. The chalazal vascular plug (c.p.) is marked, its branches running, as it seems, throughout the inner coat (i.c.). The micropyle is reached by the micropylar opening (m.) penetrating the caruncle (c.). It is interesting to compare this disposition with that of the presumed ancestral orthotropus ovule (fig. 4), which shows the caruncle as a mere labial expansion of the aril closing upon the micropyle. The passage from the anatropous pattern of *Petalostigma* and *Tetracoccus* to the presumed orthotropus disposition of the ancestor is a matter of but slight changes, involving in the main the fusion of the funiculus with the opposite wall of the aril as shown in figure 4—the funiculus thus becoming in part the raphe (r. [r.])—and the molding of the aril upon the testa to form a single, close structure. Thus the basic coats of the seed, aril, testa and inner coat are suggested as enations from the torus ending the funiculus.

This diagram is fundamental for the seed-structures of all the Euphorbiaceae, despite the fact that very great differences are found in their seeds, due to various degrees of connation and adnation between the structural components of the seed-wall, the evolution or suppression of these components and the location of the seed-reserves within the testa or, apparently, in the tissues of the aril. The obturator, as it is well known (Schweiger, Flora **94**: 379. 1905), does not belong to the seed proper but to the placenta and, perhaps, to the margins of the carpels. The caruncle, however, belongs to the seed-coat (Schweiger, loc. cit.), as shown in my diagram.

It will be noticed that the structural premises of the seed of *Petalostigma* and *Tetracoccus* are practically the same, the anatomic unity of the organs in these seeds showing that the peculiar aspect of the aril of these two genera has considerable significance as an index of consanguinity.

BULLETIN OF THE TORREY BOTANICAL CLUB
96(6): 461–470 JUNE, 1942

ASA GRAY'S EARLIEST BOTANICAL PUBLICATIONS (1833–1836)

H. W. RICKETT AND C. L. GILLY

"NORTH AMERICAN GRAMINEAE AND CYPERACEAE"

Asa Gray's first publication was entitled "A catalogue of the indigenous Flowering and Filicoid plants growing within 20 miles of Bridgewater, (Oneida Co) N. Y." It appeared in the 46th Annual Report of the Regents of the University of the State of New York (Albany, 1833); the obscurity of this publication may account for the absence of the title from the well known bibliography of Gray's work by Watson and Goodale (Am. Jour. Sci. **136** (Appendix): 1–42. 1888). The catalogue listed 785 species and 5 varieties in 352 genera. There are no descriptive notes, or introductory statements; the species are classified in the De Candollean system as modified by Lindley. Gray thought he had new species of *Scirpus*, *Erysimum*, and *Ophioglossum*, but did not name or describe them. The catalogue is noteworthy for its Cyperaceae; the 60 species of *Carex* and 11 of *Scirpus* attest his early interest in this group.

Gray's second publication in botany[1] was a century of exsiccatae accompanied by printed descriptions and synonymy, a title page, dedication, introduction, and index, entitled *North American Gramineae and Cyperaceae, Part I*. This work, issued early in 1834,[2] was supported by subscription. The demand exceeded the supply; later in the year he speaks[3] of another collecting trip to secure specimens for additional sets. That all of the examples of a given number were perhaps not collected at the same time may explain the fact that some numbers are represented by a mixture of species (see below); since some were new species, the importance of such facts is evident.

The sets, at least some of them, seem to have been issued unbound and probably unmounted. In June Gray wrote to Torrey:[4] "It will be best by all means not to trouble yourself in preparing the 2 copies of Gram. & Cyp. left with you. I will have them, with several others bound up early in the fall." The labels were printed in two columns on large sheets of paper, with

[1] Between his first two botanical works he wrote, with J. B. Crawe as senior author, "A sketch of the mineralogy of a portion of Jefferson and St. Lawrence Counties (N. Y.)" (Am. Jour. Sci. 25: 346–350. 1834).

[2] The date is established by a letter to Torrey, dated 8 May 1834, now in the library of the New York Botanical Garden. This letter and others to which reference is made have been published in *Letters of Asa Gray*, edited by Jane Loring Gray (1893).

[3] Letter to Torrey, 9 June 1834.

[4] This is from the letter of 9 June 1834 referred to above. These sentences are written in the margin and are not included in the published version of the letters.

guide lines to show where they should be cut. A bound copy of Part I is preserved in the library of the New York Botanical Garden; several additional specimens with identical labels are scattered through the herbarium. A similar dispersed set is in the Gray Herbarium, and a bound copy is in the herbarium of the Philadelphia Academy of Natural Sciences. Other bound or dispersed sets are undoubtedly in existence. The paper used for mounting the specimens in the New York copy of Part I differs from that upon which the labels and introductory matter are printed and appears to be the same as that used in mounting contemporary specimens of the Torrey Herbarium.

The second century (*North American Gramineae and Cyperaceae, Part II*) was issued in 1835[5] apparently in much the same form as Part I. A complete bound set of this issue of exsiccatae is preserved in the herbarium of the Philadelphia Academy of Natural Sciences.[6] The paper on which title page, index, and printed labels are printed appears to be of the same kind as that used in Part I. The printing of both was done by J. Post, Printer, 101 John Street, New York. A considerable number of separate sheets of this second century are in the herbarium of the New York Botanical Garden, and other sets are doubtless on file elsewhere. As additional evidence that these exsiccatae were issued as loose sets of specimens, and not as bound volumes, the mounting paper used in the Philadelphia copy of Part II differs from that of the New York copy of Part I, as well as from that on which title page, index, and labels were printed.

The collections were made largely in the pine barrens and on the coast of New Jersey and in the central and western parts of New York. A passage in Gray's autobiography[7] fixes the dates of his collections in New Jersey as 1833 and in New York as between 1828 and 1835.

The principal interest of these sets is that in them new species were described, new combinations made, and new names given. Some of these had been named by Torrey while preparing his (unpublished) Synoptical Flora; though their authorship is quite clearly indicated by Gray, they have been frequently wrongly ascribed to Gray, or sometimes to Torrey with erroneous citation of the place of publication. Some of these errors derive from the fact that certain authors have not regarded the *Gramineae and Cyperaceae* as a publication; many of the references to Trinius, when followed up, show that he had access to a set of this work and was one of the first to use the names there published (see, for instance, *Muhlenbergia sylvatica* below). The new species, combinations, and names (principally

[5] Letter to W. J. Hooker of 4 April 1835.

[6] We are glad to acknowledge the courtesy of Dr. F. W. Pennell in making this volume available for our examination.

[7] Published in *Letters of Asa Gray.*

nomina nuda), with their present status, and some of the most widely quoted erroneous references are listed below.

VILFA SEROTINA Torrey in Gray, N. Am. Gram. & Cyp. **1**: 2. 1834 (based on *Agrostis serotina* Torrey. 1823), nomen superfluum. Hitchcock (Man. Gr. U. S. 895) includes under *Muhlenbergia uniflora* (Muhl.) Fernald: "*Vilfa serotina* Trin., Gram. Icon. 3: pl. 251. 1830. . . . '*Agrostis serotina* Nutt. MS.' " This was apparently an independent and earlier publication of the same name for the same species, based on a different type. Both *V. serotina* Torr. and *V. serotina* Trin. must be regarded as new names rather than as new combinations since both *A. serotina* Torrey and *A. serotina* Nutt. are later homonyms of *A. serotina* Lam. (1767), a distinct species. The Index Kewensis wrongly ascribes *V. serotina* to "Torr. ex Trin. Sp. Gram. iii, t. 251."

VILFA VAGINIFLORA Torrey in Gray, N. Am. Gram. & Cyp. **1**: 3. 1834 (nomen novum for *Agrostis virginica* Muhl. and other authors. Not *A. virginica* L. 1753), = *Sporobolus vaginiflorus* (Torr.) Wood, Class Book 775. 1861; so cited by Hitchcock (Man. Gr. U. S. 961). In his *Flora of New York* (**2**: 438. 1843) Torrey had used the spelling *vaginaeflora*, which was adopted by Wood, and by Britton and Brown (Ill. Fl. ed. 2, **1**: 194); the latter ascribed the new combination to "Torr.; Wood Classbook 775. 1861." The Index Kewensis has "*V. vaginiflora* Torr. ex. Trin. in Mém. Acad. Pétersb. Ser. VI. Sc. Nat. v. ii. (1840) 56."

VILFA LONGIFOLIA (Torrey) Torrey in Gray, N. Am. Gram. & Cyp. **1**: 4. 1834 (based on *Agrostis longifolia* Torrey, Fl. U. S. **1**: 90. 1823). Hitchcock (Man. Gr. U. S. 958), under *Sporobolus asper* (Michx.) Kunth, attributes this name to "Torr.; Trin., Mém. Acad. St. Pétersb. VI. Sci. Nat. 4: 107. 1840." In the Index Kewensis, the place of publication is similarly stated.

MUHLENBERGIA SYLVATICA (Torrey) Torrey in Gray, N. Am. Gram. & Cyp. **1**: 13. 1834 (based on *Agrostis sylvatica* Torrey, Fl. U. S. **1**: 87. 1823). This is recognized as a valid name by Hitchcock (Man. Gr. U. S. 894) but with the erroneous citation: "Torr.; Trin. Mém. Acad. St. Pétersb. VI. Sci. Nat. 4: 292. 1841." Trinius has "*M. sylvatica* Torr.! Synop. Flor. Ined." Britton and Brown (Ill. Fl. ed. 2, **1**: 186), in synonymy under *M. umbrosa*, give the place of publication as "Cat. Pl. N. Y. State 188. 1840."

AGROSTIS MICHAUXII var. LAXIFLORA (Michx.) Gray, N. Am. Gram. & Cyp. **1**: 17. 1834 (based on *Trichodium laxiflorum* Michx. 1803). This combination is not listed by Hitchcock in the Manual; *Trichodium laxiflorum* Michx., however, is included in the synonymy of *Agrostis hiemalis* (Walt.) BSP. (Man. Gr. U. S. 781).

CALAMAGROSTIS COARCTATA (Torrey) Torrey in Gray, N. Am. Gram. & Cyp. **1**: 19. 1834 (based on *Arundo coarctata* Torrey. 1823). Hitchcock (Man. Gr. U. S. 820), under *Calamagrostis cinnoides* (Muhl.) Barton, has "*Calamagrostis coarctata* Torr.; Hook., Fl. Bor. Amer. 2: 240. 1840. Presumably based on *Arundo coarctata* Torr. Published as new in Torr., Fl. N. Y. 2: 444. pl. 151. 1843. Based on *A. coarctata* Torr." In both the Hooker

and Torrey publications cited by Hitchcock, the combination is correctly cited. The Index Kewensis ascribes *C. coarctata* to "Torr. Fl. N. York, ii. 444."

CALAMAGROSTIS EXPANSA Gray, N. Am. Gram. & Cyp. **1**: 20. 1834. Hitchcock (Man. Gr. U. S. 820) accepts and correctly cites this species. In the Index Kewensis, the citation is "A. Gray, ex Torr. Fl. N. Y. ii. 445. t. 152 [1843]." Britton and Brown (Ill. Fl. ed. 2, **1**: 210) refer the species to "A. Gray; Torr. Fl. U. S. **2**: 445. 1843."

PANICUM XANTHOPHYSUM Gray, N. Am. Gram. & Cyp. **1**: 28. 1834. Hitchcock (Man. Gr. U. S. 916) regards this as a good species and cites it correctly. The Index Kewensis has "A. Gray, Man. Bot. N. U. S. St. ed. 1. 613. [1848.]" Britton and Brown (Ill. Fl. ed. 2, **1**: 158) refer it to "Ann. Lyc. N. Y. **3**: 233. 1835."

PANICUM NITIDUM var. CRASSIFOLIUM Gray, N. Am. Gram. & Cyp. **1**: 30. 1834, nomen nudum. Hitchcock (Man. Gr. U. S. 913) under *Panicum sphaerocarpon* Ell., ascribes this variety to "A. Gray; Doell, in Mart., Fl. Bras. 2: 247. 1877." Doell (l.c.) attributed the variety to Asa Gray, provided it with a brief description, but said that it was a different species. Whether this can be said to "validate" Gray's nomen nudum is debatable.

CYPERUS MARISCOIDES var. SETIFOLIUS Torrey in Gray, N. Am. Gram. & Cyp. **1**: 75. 1834, nomen nudum.[8] This varietal name, though cited by Torrey in synonymy under *C. grayii* (Fl. N. Y. **2**: 342. 1843), has apparently never been provided with a description.

ERIOPHORUM POLYSTACHION var. TENELLUM (Nutt.) Torrey in Gray, N. Am. Gram. & Cyp. **1**: 91. 1834 (based on *E. tenellum* Nutt. 1818). Fernald (Rhodora **7**: 87. 1905) gave the correct citation for this combination, but erroneously attributed it to Gray.

PANICUM NITIDUM var. VILLOSUM Gray, Gram. & Cyp. **2**: 111. 1835. This should probably be regarded as a new name. In the synonymy of this number Gray cites, "P. pubescens. *Lam'k. Enc. Meth.* IV. *p.* 748? *Muhl. Gram.* p. 116?"

PANICUM NITIDUM var. ANGUSTIFOLIUM (Ell.) Gray, Gram. & Cyp. **2**: 112. 1835 (based on *P. angustifolium* Ell. 1816). This is obviously based on *Panicum angustifolium* Ell. although Gray made a double error in the citation of the name-bringing synonym: "*P. angustifolium* Trin. Gram. Panic. p. 223." On this page only two specific names appear: *P. lancearium* Trin. (which is the second synonym cited by Gray for the specimen now under discussion) and *P. clandestinum* L. It would seem quite logical to assume that the "223" of Gray's citation is merely a typographical error for 234, on which page *P. angustifolium* Ell. is mentioned; and that in accrediting the species *P. angustifolium* to Trinius he was merely following the common

[8] Those who still recognize the distinctions made in the "American Rules" of 1907 will regard this and several other names here listed as hyponyms rather than nomina nuda.

practice of that day, of referring to a publication at hand which contained a description of a species originally published by another author. Except for the glabrous leaf sheaths, the specimen of no. 112 in the Philadelphia copy of Part II matches the description of *P. angustifolium* given by Trinius.

URACHNE CANADENSIS (Poir.) Torrey in Gray, Gram. & Cyp. **2**: 114. 1835 (based on *Stipa canadensis* Poir. 1806). This specific name, included in synonymy under *Oryzopsis canadensis* (Poir.) Torr. by Hitchcock (Man. Gr. U. S. 897), is accredited by him to "Tor. & Gray;" also, although he correctly cites the place of publication, the date is given as "1836." In the Index Kewensis the citation for this name is "Torr. & Gray, ex Trin. & Rupr. l.c. v(1842) 17 [Sp. Gram. Stip.]." Examination of this publication reveals that Trinius and Ruprecht attributed the name to "Torr. & Gray! Gram. et Cyp. exsicc. (1836) n. 14," and cited it only as a synonym.

TRITICUM REPENS var. GLAUCUM Gray, Gram. & Cyp. **2**: 128. 1835, nomen nudum. So far as we can determine the variety has never been described.

CAREX PENSYLVANICA var. MUHLENBERGII Gray, Gram. & Cyp. **2**: 163. 1835 (nomen novum for *C. varia* Muhl. ex Wahl. 1803). Mackenzie (N. Am. Fl. **18**: 194. 1935) cites this name in synonymy under *C. communis* as follows: "*Carex pennsylvanica* var. *Muhlenbergii* A. Gray (N. Am. Gram. *163.* 1835); Torr. Ann. Lyc. N. Y. **3**: 410. 1836. (As to plant described only.)" The specimen on sheet 163 of the Philadelphia copy of Part II agrees with Mackenzie's conception of *C. communis.*

CAREX OLIGOCARPA var. LATIFOLIA Gray, Gram. & Cyp. **2**: 178. 1835, nomen nudum; Torr. & Gray in Torr. Ann. Lyc. N. Y. **3**: 415. 1836. Mackenzie (N. Am. Fl. **18**: 250. 1935) cites this name in synonymy under *C. laxiculmis* as follows: "*Carex oligocarpa* var. *latifolia* A. Gray (N. Am. Gram. *no. 178* ex. syn. 1835); Torr. Ann. Lyc. N. Y. **3**: 415. 1836. (Type from Watertown, New York.)" The variety was described (Ann. Lyc. N. Y. **3**: 415. 1836) as follows: ". . . in this variety (*C. oligocarpa* var. *latifolia, Gray, Gram. & Cyp.* part 2. no. 178) the leaves are usually glaucous, the spikes more densely flowered, and the fruit usually somewhat larger." The plant on the Philadelphia sheet of no. 178 agrees with this meager description, and is certainly referable to *C. laxiculmis.*

It should also be noted that on the specimen labels, both *Festuca nutans* and *Festuca pratensis* are designated, through apparent typographical error, as number 125. However, in the index of the copy now before us, the former is listed as number 125 and the latter as number 126.

For the typification of the new species and varieties represented in this list it becomes necessary to cite a particular example of the many sets distributed, particularly since some are not homogeneous. Hitchcock and Chase (Contr. U. S. Nat. Herb. **15**: 290. 1910) designated as type of *Panicum xanthophysum* a sheet in the Gray Herbarium annotated in Gray's hand with the location "Oneida Lake, Wood Creek barrens." We should surely

regard as the type for a species one of the specimens issued in the publication in which it was described. In a later work (N. Am. Fl. **17**: 278. 1915) Hitchcock indeed names as type locality "Pine Plains, near Oneida Lake," a quotation from the printed label of No. 28 of the *Gramineae and Cyperaceae*. We here designate as types of the new species and varieties described in this work the corresponding specimens in the bound copy in the library of the New York Botanical Garden.

PAPERS IN THE ANNALS OF THE NEW YORK LYCEUM

In December 1834, Gray, who was then Torrey's assistant in the College of Physicians and Surgeons of New York, read before the Lyceum of Natural History of New York a paper entitled "A Monograph of the North American species of Rhynchospora." In this he described fifteen new species and made two new combinations; two of the novelties are based on specimens issued in the *North American Gramineae and Cyperaceae, Part I.*[9] *R. torreyana* is based on no. 96 of this work. According to personal communications of Miss Shirley Gale, the no. 96 of the bound copy in the New York Botanical Garden is actually *R. torreyana*, while the correspondingly numbered specimen at the Gray Herbarium is *R. gracilenta* (perhaps collected at a different time). *R. gracilenta* is based on no. 93 of the *Gramineae and Cyperaceae*. Our specimen again is actually *R. gracilenta*, while that at the Gray Herbarium is *R. fusca* (as labeled). This situation makes it the more imperative that specific sheets be designated as types of the species described in or on the basis of this work. Miss Gale has annotated as type of *R. torreyana* a specimen collected by Gray at Quaker Bridge, N. J., in August 1833. As type of *R. gracilenta* she has annotated a specimen, apparently collected by Gray, in the Pine Barrens of New Jersey in September 1834. Both of these specimens were formerly in the Torrey Herbarium, and are now in the herbarium of the New York Botanical Garden.

The paper on *Rhynchospora* and another read at the same time ("A notice of some new, rare, or otherwise interesting Plants, from the Northern and Western portions of the State of New York") were printed in volume 3 of the Annals of the Lyceum of Natural History of New York. In a letter to Hooker dated 4 April 1835 Gray speaks of sending the second part of the *Gramineae and Cyperaceae*, and further writes: "I inclose in the same parcel the loose sheets of an unpublished portion of the third volume of the 'Annals of the New York Lyceum of Natural History,' comprising an attempt at a monography of the genus *Rhynchospora*. A more perfect copy, with a copy of the engraving, now in the hands of the artist, will be transmitted to you by the earliest opportunity." These "loose sheets" must have

[9] Two others are published for Baldwin from his manuscript, and one for Torrey.

been printed but unbound sheets.[10] On 10 October 1836 he wrote: "All the sheets of the monograph 'Rhynchosporae' were destroyed by fire soon after being printed, and when reprinted, about a year since, I added a few observations, notes of additional localities, etc. But . . . I find there are several errors (several of which are quite material). . . . I send herewith the sheets of the paper as published here, with such typographical corrections as now occur to me." Ames (Orchidaceae **4**: 137–138. 1910) presents evidence that these pages of the Annals were finally issued in April 1836. Meanwhile, however, copies of the first printing had been distributed. Two are bound with other pamphlets ("separates") in the library of the New York Botanical Garden. One of these is of particular interest in having attached to it the original drawings from which Plate VI was made. Hooker printed the paper on *Rhynchospora* in the Companion to the Botanical Magazine (**2**: 26–38. 1836), obviously using the loose sheets of the first printing. In *North American Gramineae and Cyperaceae, Part II*, on the labels of no. 173, *Carex intumescens* var. *globularis*, and no. 185, *C. blepharophora*, the place of publication is given as "Ann. Lyc. Nat. Hist. New-York, III. p. 235." This is the pagination of the first printing, not of the second (see below). There is no doubt, therefore, that the papers were actually first issued early in 1835, and that this is the date of publication of the new names that appear in them. It is of interest to note that this original paper has been erroneously listed as a "reprint."

The pages of the 1836 version were set in a different type, which resulted in a lack of correspondence in pagination between the two editions. In the first printing the paper on *Rhynchospora* occupied pages 191–219, the second paper pages 220–236; in the second edition these pages are 191–220 and 221–238 respectively. This, with the question of the date, has led to discrepancies in the citation of certain new species and varieties. The correct references are as follows:

Rhynchospora torreyana Gray, Ann. Lyc. N. Y. **3**: 197. 1835.
Rhynchospora miliacea (Lam.) Gray, Ibid.: 198.
Rhynchospora multiflora Gray, Ibid.: 200.
Rhynchospora patula Gray, Ibid.: 201.
Rhynchospora microcarpa Baldwin ex Gray, Ibid.: 202.
Rhynchospora elliottii Gray, Ibid.: 204.
Rhynchospora corniculata (Lam.) Gray, Ibid.: 205.
Rhynchospora macrostachya Torrey ex Gray, Ibid.: 206.
Rhynchospora dodecandra Baldwin ex Gray, Ibid.: 207.
Rhynchospora megalocarpa Gray, Ibid.: 208.
Rhynchospora pycnocarpa Gray, Ibid.: 208.
Rhynchospora baldwinii Gray, Ibid.: 209.
Rhynchospora paniculata Gray, Ibid.: 211.
Rhynchospora oligantha Gray, Ibid.: 212.
Rhynchospora semiplumosa Gray, Ibid.: 212.
Rhynchospora gracilenta Gray, Ibid.: 215.
Rhynchospora cephalantha Gray, Ibid.: 218.

[10] It will be perhaps possible to verify this when the Hooker correspondence again becomes available for study. The Annals were issued in 8-page signatures, which would make it easy for unbound articles to be thus distributed.

Anemone cylindrica Gray, Ibid.: 220.
Nasturtium natans DC. var. *americanum* Gray, Ibid.: 222.
Draba incana L. var. *glabriuscula* Gray, Ibid.: 222.
Microstylis brachypoda Gray, Ibid.: 227.
Habenaria hookeri Torrey ex Gray, Ibid.: 228.
Vilfa heterolepis Gray, Ibid.: 232.
Carex intumescens Rudge var. *globularis* Gray, Ibid.: 235.
Carex blepharophora Gray, Ibid.: 235.
Aspidium acrostichoides Willd. var. *incisum* Gray, Ibid.: 236.

In the Index Kewensis, two of these species (*Rhynchospora gracilenta* and *Carex blepharophora*) are cited as of the original 1835 printing; others (*Rhynchospora baldwinii, Rhynchospora semiplumosa, Anemone cylindrica, Microstylis brachypoda, Habenaria hookeri* [as *H. hookeriana;* see Ames, l.c.], and *Vilfa heterolepis*) are listed with the pagination of the 1836 reprinting. Mackenzie (N. Am. Flora **18**: 194, 250. 1935) in citing *Carex blepharophora* and *C. intumescens* var. *globularis*, gives the pagination of the 1836 edition but the date as "1835."

From the portion of Gray's letter quoted above, it is evident that the second edition also must be mentioned in any reference to these papers. Not only were new locations added, but some descriptions were amplified or modified. Besides such important differences, many typographical errors were corrected in the second version (and some new ones introduced). It is interesting to note that Hooker's edition followed the first printing verbatim except for his own corrections of obvious errors and except for certain omissions for which he was responsible. For the convenience of those to whom both versions are not readily available, the more important discrepancies are listed below. The reader will identify some as due to typographical errors, some as resulting from Gray's annotations; about some, however, there is doubt.

1835	1836
page	*page*
196. [*Rhynchospora cymosa.*] *Corymbs* 3–4 . . . the terminal one largest.	196. *Corymbs* 3–4 . . . the terminal ones largest. [So changed also by Hooker.]
	196. [dded:] Middle Florida, *Dr. Chapman.*
197. [*R. Torreyana.*] *Bristles* 6, . . . ½–3/3 the length of the nut.	197. *Bristles* 6, . . . one-half to two-thirds the length of the nut. [So corrected also by Hooker.]
197. [*R. rariflora.*] *Culms* . . . 6–12 inches high.	198. *Culms* . . . 6–12 (rarely 15) inches high.
	198. [Added:] Middle Florida, *Dr. Chapman.*
198. [*R. miliacea.*] *Lower leaves* . . . 8–16 inches long. . . . *Spikelets* . . . 1—½ an inch. . . .	198. *Lower leaves* . . . 8–10 inches long. *Spikelets* . . . ¼–½ an inch. [Hooker's correction of the latter error was: half an inch.]
	199. [Added under *R. miliacea:*] Middle Florida, *Dr. Chapman.*

page	
201. [*R. multiflora.*] . . . distinguished by its much more numerous and smaller spikelets. . . .	201. . . . distinguished by its more numerous and smaller spikelets. . . .
201. I see no reason for referring this plant to the genus Scirpus.	201. [Added:] Gadsden County, Middle Florida, *Dr. Chapman.* 201. This species produces a greater number of nuts than is usual with the genus, on which account Mr. Elliott referred it to the genus Scirpus; but *R. miliacea* and *R. caduca* often ripen nearly the same number.
	205. [Added under *R. Elliottii:*] Gadsden County, Middle Florida, *Dr. Chapman.*
206. [*R. corniculata.*] . . . one of the inner series [of bristles] about ½, the 2 others ⅓ the length of the nut.	206. . . . one of the inner series about ½, and the two others ¼ the length of the nut.
206. Ohio to Louisiana;	206. Ohio to Florida;
214. [*R. fusca.*] *Culm* . . . slender, triquetrous.	215. *Culm* . . . very slender, smooth.
217. [*R. glomerata.*] Hab. In swamps, . . .	218. Hab. In bogs and moist places;
	219. [Added under *R. cephalantha:*] Gadsden County, Middle Florida, *Dr. Chapman.*
219. [*R. cephalantha.*] . . . the bristles are hispid both upward and downward.	219. . . . some of the bristles are hispid upward and others downward.
	223. [Added under *Nasturtium natans, americanum:*] Although a rare plant, its geographical range is quite extensive, as Dr. Ingalls has recently found it at New Orleans.
223. [*Draba incana* var. *glabriuscula.*] *Flowers* in a short somewhat compact raceme, simple or rarely with one or two branches.	224. *Flowers* in a short, somewhat compact, simple (or sometimes branching) raceme.
223. The habit of our plant is precisely that of *D. arabizans Pursh, non Michx.* (Alyssum dentatum, *Nutt.* which is not an Alyssum, but a genuine Draba.)	224. The habit of our plant is precisely that of *Draba ramosissima* of Desvaux (*D. arabizans, Dursh, non Michx. D. dentata, Hook & Arn.* in Hooker's Journal of Botany. *Alyssum dentatum, Nutt.*);
224. [*Ceanothus ovalis.*] This plant is undoubtedly quite distinct from *C. intermedius, Pursh,* to which it is referred by Prof. Hooker, a species which is probably confined to the southern states.	225. This plant is undoubtedly quite distinct from *C. intermedius, Pursh,* which is merely a narrow-leaved form of *C. Americanus,* nearly confined to the Southern States.
224. [*Lathyrus palustris.*]—somewhat rare.	225. [For this is substituted:] Its leaves from lanceolate (the ordinary form) to oblong-ovate.
226. [*Dracocephalum parviflorum.*] . . . Aretic America. . . .	227. . . . British N. America. . . .
	228. [Added under *Microstylis brachypoda:*] I am not certain that these characters are constant.
227. [*Habenaria orbiculata.*] *Flowers* 15–20. . . .	229. *Flowers* 17–20. . . .
	235. [Added under *Panicum xanthophysum:*] . . . and at Burlington, Vermont, by *J. Carey, Esq.*

page	*page*
	235. [Added under *Carex chordorrhiza:*] I have recently received this plant, hitherto unknown in this country, from Seneca County, *Dr. Sartwell,* and St. Lawrence County, *Dr. Crawe.*
234. [*Carex livida.*] I have never noticed the distant or subradical peduncles. . . .	235. I have never, except in a single specimen, noticed the distant or subradical peduncles. . . .
	238. [Added under *Carex Hitchcockiana:*] Cayuga County, *J. Carey.*

Gray's next botanical work, not listed in the available bibliographies, was a further revision of the North American *Rhynchosporae* and a joint endeavor with Torrey on the *Carices* of North America. These were printed as a part of Torrey's *Monograph of North American Cyperaceae* (Ann. Lyc. Nat. Hist. N. Y. **3**: 239–443. 1836.). In his introductory remarks, Torrey wrote: "The revision of the Rhynchosporae is entirely his [Gray's] own; and the Synopsis of North American Carices, I wish to have considered as our joint performance." The correct citations for species or combinations published in these portions of the "Monograph" have already been discussed by one of us.[11]

THE NEW YORK BOTANICAL GARDEN
NEW YORK, N. Y.

[11] C. Gilly, A note on the authorship of certain species of cyperaceae. Rhodora **43**: 333–335. 1941.

INDEX TO AMERICAN BOTANICAL LITERATURE

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Papers that relate exclusively to bacteriology, forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

PLANT TAXONOMY AND FLORISTICS
(exclusive of fungi)

Beard, J. S. Montane vegetation in the Antilles. Carib. Forester **3**: 61–74. *diagr. 1–4.* Ja 1942.

Benson, L. North American Ranunculi—IV. Bull. Torrey Club **69**: 298–316. 1 Ap 1942. V. **69**: 373–386. 1 My 1942.

Britton, M. E. & Smith, B. H. A new species of *Spirogyra*. Ohio Jour. Sci. **42**: 70. *1 f.* Mr 1942.

Chandler, A. Fragrant fern about Lake Superior. Am. Fern Jour. **32**: 13, 14. Ja–Mr 1942.

Clover, E. U. A new species and variety of *Sclerocactus* from Arizona. Am. Jour. Bot. **29**: 172–173. *f. 1–4.* 10 Mr 1942.

Corcoran, M. L. A revision of the subgenus *Pycreus* in North and South America. Catholic Univ. Am. Biol. Ser. 37: i–xvi, 1–68. 1941.

Core, E. L. & Davis, H. A. Additions to the catalogue of the vascular plants of West Virginia: I. Proc. W. Va. Acad. **15**: 73–76. F 1942.

Deam, C. C. Emendations and changes in nomenclature in Deam's Flora of Indiana (1940). Dept. Conservation, Indianapolis, Ind. p. 1–9. 1 Jl 1941.

Dix, W. L. Braun's holly-fern in Pennsylvania. Am. Fern Jour. **32**: 37. Ja–Mr 1942.

Duman, M. G. The genus *Carex* in Eastern Arctic Canada. Catholic Univ. Am. Biol. Ser. 36: 1–84. 1941.

Ensign, M. A revision of the celastraceous genus *Forsellesia* (*Glossopetalon*). Am. Midl. Nat. **27**: 501–511. *f. 1–8.* Mr 1942.

Fassett, N. C. Mass collections: *Diervilla Lonicera*. Bull. Torrey Club **69**: 317–322. *f. 1.* 1 Ap 1942.

Fassett, N. C. Mass collections: *Ranunculus abortivus* and its close relatives. Am. Midl. Nat. **27**: 512–522. *f. 1–6.* Mr 1942.

Fernald, M. L. *Carex corrugata* from Alabama. Rhodora **44**: 76. 7 Mr 1942.

Fernald, M. L. Formal transfers in *Cyperus*. Rhodora **44**: 151. Ap 1942.

Fernald, M. L. Some color-forms of *Gentiana Porphyrio*. Rhodora **44**: 51, 52. Ap 1942.

Gilly, C. The genus *Cephalocarpus* Nees (Cyperaceae). Bull. Torrey Club **69**: 290–297. *f. 1.* 1 Ap 1942.

Horvat, M. L. A revision of the subgenus *Mariscus* found in the United States. Catholic Univ. Am. Biol. Ser. 33: 1–147. 1941.

Keller, A. C. *Acer glabrum* and its varieties. Am. Midl. Nat. **27**: 491–500. *pl. 1, 2.* Mr 1942.

Kittell, M. T. A critical revision of the Compositae of Arizona and New Mexico. Catholic Univ. Am. Biol. Ser. 34: 342–507. *pl. 1, 2.* 1941.

Little, E. L. A first Arizona record of *Botrychium multifidum*. Am. Fern Jour. **32**: 26, 27. Ja–Mr 1942.

Maguire, B. Great Basin plants—VII. *Cruciferae*. Am. Midl. Nat. **27**: 463–469. Mr 1942.

Moran, R. The Crassulaceae of Yosemite National Park. Desert **14**: 5–9. *illust.* Ja 1942.

Mousley, H. The spring ladies' tresses (*Spiranthes vernalis* Engelm. & Gray) in Canada. Canad. Field Nat. **56**: 1, 2. *pl. 1, 2.* Ja 1942.

Muller, C. H. Notes on the American flora, chiefly Mexican. Am. Midl. Nat. **27**: 470–490. Mr 1942.

Murrill, W. A. New Florida hawthorns. Castanea **7**: 19–30. F 1942.

Pennell, F. W. Some new Scrophulariaceae from Montana and adjacent Idaho and Wyoming. Not. Nat. 95: 1–11. *f. 1, 2.* 27 Mr 1942.

Pierce, J. H. A plant new to the western hemisphere. Carib. Forester **3**: 88. 1942.

Prescott, G. W. & Scott, A. M. The fresh-water algae of southern United States I. Desmids from Mississippi, with descriptions of new species and varieties. Trans. Am. Micros. Soc. **61**: 1–29. *pl. 1–3.* Ja 1942.

Ramaley, F. Vegetation of the San Luis Valley in southern Colorado. Univ. Colorado Stud. Ser. D **1**: 231–277. *f. 1–8.* Mr 1942.

Sandwith, N. Y. Contributions to the flora of tropical America: XLV. New plants from the Andes of Venezuela and Colombia. Kew Bull. Misc. Inf. **1941**[3]: 218–228. 1942.

Sandwith, N. Y. Contributions to the flora of tropical America: XLVI. The *Haiariballis* of British Guiana. Kew Bull. Misc. Inf. **1941**[3]: 228–232. 1942.

Schweinfurth, C. Nomenclatorial notes in *Pleurothallis*. Bot. Mus. Leafl. **10**: 139, 140. 27 Mr 1942.

Schweinfurth, C. Orchidaceae peruvianae III. Bot. Mus. Leafl. **10**: 113–128. *pl. 12–16.* 27 Mr 1942.

Shreve, F. The desert vegetation of North America. Bot. Rev. **8**: 195–246. Ap 1942.

Steyermark, J. A. Rediscovering *Sedum pulchellum* at its northeastern limit. Rhodora **44**: 73–76. 7 Mr 1942.

Steyermark, J. A. Two albino forms of *Echinacea* from Missouri. Rhodora **44**: 150, 151. Ap 1942.

Turrill, W. B. Taxonomy and phylogeny. Bot. Rev. **8**: 247–270. Ap 1942.

Wagner, W. H. Bipinnate Christmas ferns. Am. Fern Jour. **32**: 27–29. Ja–Mr 1942.

Weber, W. A. *Geranium Bicknellii* earlier than *G. nemorale*. Torreya **44**: 91, 92. Mr 1942.

Williams, L. O. A new *Epidendrum* from Mexico. Am. Orchid Soc. Bull. **10**: 309, 310. *pl. 10.* 7 Mr 1942.

MORPHOLOGY
(including anatomy, and cytology in part)

Bailey, I. W. & Berkley, E. E. The significance of x-rays in studying the orientation of cellulose in the secondary wall of tracheids. Am. Jour. Bot. **29**: 231–241. *f. 1–18.* 2 Ap 1942.

Bannan, M. W. Wood structure of the native Ontario species of *Juniperus*. Am. Jour. Bot. **29**: 245–251. *f. 1–30.* 2 Ap 1942.

Doyel, B. E. Some features of the structure of *Arctostaphylos viscida*. Am. Jour. Bot. **29**: 254–259. *f. 1–32*. 2 Ap 1942.

Eames, A. J. Illustrations of some *Lycopodium* gametophytes. Am. Fern Jour. **32**: 1–12. *pl. 1–4*. Ja–Mr 1942.

Farrar, J. L. & Grace, N. H. Vegetative propagation of conifers. XI. Effects of type of cutting on the rooting of Norway spruce cuttings. Canad. Jour. Res. C **20**: 116–121. *pl. 1 + f. 1*. F 1942.

[Fulling, E. H. ed.] The diploid cell and the diploidisation process in plants and animals, with special reference to the higher fungi—criticism and rebuttal. Bot. Rev. **8**: 191–193. Mr 1942.

Jones, J. W. & Pope, M. N. Adventitious roots on panicles of rice. Jour. Hered. **33**: 55–58. *f. 7–8*. F 1942.

La Rue, C. D. The rooting of flowers in sterile culture. Bull. Torrey Club **69**: 332–341. *f. 1*. 1 My 1942.

Lovell, H. B. Pollination of the Ericaceae: VI. *Vaccinium caespitosum* on Mt. Katahdin. Rhodora **44**: 187–189. *1 f.* My 1942.

Sharpe, M. R. Hart's-tongue division. Am. Fern Jour. **32**: 25, 26. Ja–Mr 1942.

Sinnott, E. W. An analysis of the comparative rates of cell division in various parts of the developing cucurbit ovary. Am. Jour. Bot. **29**: 317–323. *f. 1*. 2 My 1942.

Smith, A. I. Adventitious roots in stem cuttings of *Tropaeolum majus* L. Am. Jour. Bot. **29**: 192–194. *f. 1–8*. 10 Mr 1942.

Stewart, R. N. & Bamford, R. The chromosomes and nucleoli of *Medeola virginiana*. Am. Jour. Bot. **29**: 301–303. *f. 1–13*. 2 My 1942.

Stokey, A. G. Gametophytes of *Marattia sambucina* and *Macroglossum smithii*. Bot. Gaz. **103**: 559–569. *f. 1–30*. 8 Ap 1942.

Thompson, R. H. The morphology of *Riella affinis*. II. Development of the sex organs, fertilization, and development of the sporophyte. Am. Jour. Bot. **29**: 275–281. *f. 68–104*. 2 Ap 1942.

Thomson, B. F. The floral morphology of the Caryophyllaceae. Am. Jour. Bot. **29**: 333–349. *f. 1–36*. 2 My 1942.

Weatherby, C. A. Proliferous Scott's spleenwort. Am. Fern Jour. **32**: 23–25. *1 f.* Ja–Mr 1942.

Wolcott, G. B. Spore germination and polarity in *Pallavicinia Lyellii*. Bryologist **45**: 29–34. *f. 1–26*. Ap 1942.

Wu, Su-Hsua. Cytological studies on *Spironema fragrans* Lindl. and certain other Commelinaceae. Papers Mich. Acad. **27**[1] (1941): 117–135. *pl. 1–10*. Mr 1942.

PLANT PHYSIOLOGY

(See also under Mycology: **Yarwood**)

Albrecht, W. A., Graham, E. R. & Shepard, H. R. Surface relationships of roots and collodial clay in plant nutrition. Am. Jour. Bot. **29**: 201–213. 2 Ap 1942.

Alexander, T. R. Anatomical and physiological responses of squash to various levels of boron supply. Bot. Gaz. **103**: 475–491. *f. 1–5*. 8 Ap 1942.

Alexopoulos, C. J. & Herrick, J. A. Studies in antibiosis between bacteria and fungi—III. Inhibitory action of some *Actinomycetes* on various species of fungi in culture. Bull. Torrey Club **69**: 257–261. 1 Ap 1942.

Allardyce, J. & Milsom, D. Carotene in feed grasses. Canad. Jour. Res. C **20**: 85–88. F 1942.

Bonner, J. Riboflavin in isolated roots. Bot. Gaz. **103**: 581–585. 8 Ap 1942.

Bonner, J. Transport of thiamin in the tomato plant. Am. Jour. Bot. **29**: 136–142. Mr 1942.

C-Glasstone, V. F. Passage of air through plants and its relation to measurement of respiration and assimilation. Am. Jour. Bot. **29**: 156–159. 10 Mr 1942.

Davis, W. B. The distribution and preparation of citrus peroxidase. Am. Jour. Bot. **29**: 252–254. 2 Ap 1942.

Greenfield, S. S. Inhibitory effects of inorganic compounds on photosynthesis in *Chlorella*. Am. Jour. Bot. **29**: 121–131. *f. 1–20*. 10 Mr 1942.

Hamner, K. C., Lyon, C. B. & Hamner, C. L. Effect of mineral nutrition on the ascorbic-acid content of the tomato. Bot. Gaz. **103**: 586–616. *f. 1–13*. 8 Ap 1942.

Hamner, M. E. Effect of phenylacetic acid and naphthalene acetamide on tomato plants grown in soil. Bot. Gaz. **103**: 576–580. 8 Ap 1942.

Hansen, E. Quantitative study of ethylene production in relation to respiration of pears. Bot. Gaz. **103**: 543–558. *f. 1–7*. 8 Ap 1942.

Hayward, H. E. & Blair, W. M. Some responses of Valencia orange seedlings to varying concentrations of chloride and hydrogen ions. Am. Jour. Bot. **29**: 148–155. *f. 1–9*. 10 Mr 1942.

Heinze, P. H., Parker, M. W. & Borthwick, H. A. Floral initiation in Biloxi soybean as influenced by grafting. Bot. Gaz. **103**: 518–530. *f. 1–3*. 8 Ap 1942.

Lammerts, W. E. Embryo culture as effective technique for shortening the breeding cycle of deciduous trees and increasing germination of hybrid seed. Am. Jour. Bot. **29**: 166–171. 10 Mr 1942.

Leonard, J. M. A study of soy bean esterase. Catholic Univ. Amer. Biol. Ser. 39: 1–81. 1941.

Nightingale, G. T. Nitrate and carbohydrate reserves in relation to nitrogen nutrition of pineapple. Bot. Gaz. **103**: 409–456. *f. 1–14*. 8 Ap 1942.

Overstreet, R. *et al.* Additional studies regarding the cation absorption mechanism of plants in soil. Am. Jour. Bot. **29**: 227–231. *f. 1, 2*. 2 Ap 1942.

Patterson, E. K. The photodynamic action of neutral red on root tips of barley seedlings. Part II. Abnormalities of cells and tissue. Am. Jour. Bot. **29**: 109–121. *f. 1–44*. 10 Mr 1942.

Pratt, R. Studies on *Chlorella vulgaris*. V. Some properties of the growth-inhibitor formed by *Chlorella* cells. Am. Jour. Bot. **29**: 142–148. *f. 1–5*. 10 Mr 1942.

Raper, J. R. Sexual hormones in *Achlya*. III. Hormone A and the initial male reaction. Am. Jour. Bot. **29**: 159–166. *f. 1–6*. 10 Mr 1942.

Robbins, W. J. Specificity of pyridoxine for excised tomato roots. Am. Jour. Bot. **29**: 241–245. 2 Ap 1942.

Robbins, W. J. & Kavanagh, F. Hypoxanthine, a growth substance for *Phycomyces*. Proc. Nat. Acad. **28**: 65–69. *f. 1*. 15 Mr 1942.

Schneider, C. L. On the nastic and traumatic responses in the pea test. Am. Jour. Bot. **29**: 201–206. *f. 1–7*. 2 Ap 1942.

Shirk, H. G. Freezable water content and the oxygen respiration in wheat and rye grain at different stages of ripening. Am. Jour. Bot. **29**: 105–109. *f. 1–6*. 10 Mr 1942.

Stewart, W. S. & Anderson, M. S. Auxins in some American soils. Bot. Gaz. **103**: 570–575. 8 Ap 1942.

Ulrich, A. Metabolism of organic acids in excised barley roots as influenced by temperature, oxygen tension and salt concentration. Am. Jour. Bot. **29**: 220–227. *f. 1–7*. 2 Ap 1942.

Wessel, C. J. A study of the esterase activity of *Aleurites Fordii*. Catholic Univ. Amer. Biol. Ser. 38: 1–72. 1941.

MYCOLOGY AND PHYTOPATHOLOGY

(See also under Plant Physiology: **Alexopoulos & Herrick; Robbins & Kavanagh;** under Morphology: **Fulling**)

Baur, E. On the etiology of infectious variegation. Phytopath. Classics 7: 55–62. 1942.

Beijerinck, M. W. Concerning a contagium vivum fluidum as a cause of the spot disease of tobacco leaves. Phytopath. Classics 7: 33–52. *pl. 1, 2.* 1942.

Berdan, H. B. A developmental study of three saprophytic chytrids. III. *Septochytrium variabile* Berdan. Am. Jour. Bot. **29**: 260–270. *f. 1–52.* 2 Ap 1942.

Bisby, G. R., Mason, E. M. & Wakefield, E. M. A note on nomenclature. Mycologia **34**: 215–217. 1 Ap 1942.

Bonar, L. Studies on some California fungi II. Mycologia **34**: 180–192. *f. 1, 2.* 1 Ap 1942.

Davidson, R. W., Campbell, W. A. & Weber, G. F. *Ptychogaster cubensis*, a wood-decaying fungus of southern oaks and waxmyrtle. Mycologia **34**: 142–153. *f. 1–3.* 1 Ap 1942.

Dodge, B. O. A note on segregation types in *Glomerella*. Mycologia **34**: 219–221. 1 Ap 1942.

Elliott, C. Bacterial wilt of dent corn inbreds. Phytopathology **32**: 262–265. Mr 1942.

Ivanowski, D. Concerning the mosaic disease of the tobacco plant. Phytopath. Classics 7: 27–30. 1942.

Jenkins, A. E. *Ascochyta majalis* identified on lily of the valley in the United States. Phytopathology **32**: 259–261. *f. 1.* Mr 1942.

Jenkins, J. M. Downy mildew resistance in cucumbers. Jour. Hered. **33**: 35–38. *f. 1–3.* F 1942.

Jensen, J. H. & Goss, R. W. Physiological resistance to halo blight in beans. Phytopathology **32**: 246–253. *f. 1–3.* Mr 1942.

Karling, J. S. A synopsis of *Rozella* and *Rozellopsis*. Mycologia **34**: 193–208. 1 Ap 1942.

Kung-Hsiang, L. A physiological study of the susceptibility of the blushed and green sides of apples to certain fungous rots. Phytopathology **32**: 239–245. Mr 1942.

Lockhead, A. G. *Zygosaccharomyces nectarophilus* n. sp. and *Zygosaccharomyces rugosus* n. sp. Canad. Jour. Res. C **20**: 89–91. F 1942.

Long, W. H. Studies in the Gasteromycetes. V. A white *Simblum*. Mycologia **34**: 128–131. *f. 1, 2.* 1 Ap 1942.

McCranie, J. Sexuality in *Allomyces cystogenus*. Mycologia **34**: 209–213. *1 f.* 1 Ap 1942.

Martin, G. W. Clamp-connections in the Tremellales. Mycologia **34**: 132–138. 1 Ap 1942.

Mayer, A. Concerning the mosaic disease of tobacco. Phytopath. Classics 7: 11–24. *pl. 3.* 1942.

Mrak, E. M., Phaff, H. J. & Smith, B. L. Non-validity of the genus *Asporomyces*. Mycologia **34**: 139–141. 1 Ap 1942.

Nemeth, F. F. Insect galls of West Virginia. I. Galls on *Ulmus, Hamamelis, Rubus* and *Prunus*. Castanea **7**: 16–19. *pl. 1.* F 1942.

Pomerleau, R. The spherical gall rust of Jack pine. Mycologia **34**: 120–122. *1 f.* 1 Ap 1942.

Ray, W. W. & McLaughlin, J. H. Isolation and infection tests with seed- and soil-borne cotton pathogens. Phytopathology **32**: 233–238. Mr 1942.

Ritchie, D. Origin of the bulliform cells in the lamellae of *Russula*. Castanea **7**: 13–15. *f. 1–5*. F 1942.

Seaver, F. J. *Plectania coccinea*. Mycologia **34**: 119. *1 col. pl.* 1 Ap 1942.

Shanor, L. A new fungus belonging to the Cladochytriaceae. Am. Jour. Bot. **29**: 174–179. *f. 1–38*. 10 Mr 1942.

Smith, C. O. & Smith, D. J. Host range and growth temperature relations of *Coryneum beijerinckii*. Phytopathology **32**: 221–225. *f. 1–3*. Mr 1942.

Sokoloff, V. P. & Klotz, L. J. Mortality of the red scale on citrus through infection with a spore-forming bacterium. Phytopathology **32**: 187–198. *f. 1–3*. Mr 1942.

Stout, A. B. Puff-balls in Ohio. Mycologia **34**: 217–219. *1 f.* 1 Ap 1942.

Wang, Y. O. Rust reactions of Chinese wheat varieties and certain Canadian hybrid strains. Canad. Jour. Res. C **20**: 108–115. F 1942.

Weiss, F., Haasis, F. A. & Williamson, C. E. Prestorage disinfection of narcissus bulbs. Phytopathology **32**: 199–205. Mr 1942.

Weston, W. H. The conidial phase of *Sclerospora noblei*. Phytopathology **32**: 206–213. *f. 1*. Mr 1942.

White, W. L. Studies in the genus *Helotium*. I. A review of the species described by Peck. Mycologia **34**: 154–179. *f. 1–10*. 1 Ap 1942.

Yarwood, C. E. Stimulatory and toxic effects of copper sprays on powdery mildews. Am. Jour. Bot. **29**: 132–135. 10 Mr 1942.

Young, P. A. Varietal resistance to blossom-end rot in tomatoes. Phytopathology **32**: 214–220. *f. 1*. Mr 1942.

Zundel, G. L. Studies on the Ustilaginales of the world II. Mycologia **34**: 123–127. 1 Ap 1942.

GENETICS
(including cytogenetics)

Babcock, E. B. Systematics, cytogenetics and evolution in *Crepis*. Bot Rev. **8**: 139–190. Mr 1942.

Beal, J. M. Chromosome fragments in *Lilium willmottiae* and hybrids between it and *L. davidii*. Bot. Gaz. **103**: 617–619. *f. 1–9*. 8 Ap 1942.

Bindloss, E. A developmental analysis of cell length as related to stem length. Am. Jour. Bot. **29**: 179–188. *f. 1–15*. 10 Mr 1942.

Cooper, D. C. & Brink, R. A. The endosperm as a barrier to interspecific hybridization in flowering plants. Science **95**: 75, 76. 16 Ja 1942.

James, W. M. & Addicott, F. T. Preliminary report on time of flower formation and chromosome numbers in *Nerine*. Herbertia **8**: 111–116. *f. 65, 66*. Ja 1942.

Peto, F. H. & Young, G. A. Hybridization of *Triticum* and *Agropyron*. VII. New fertile amphidiploids. Canad. Jour. Res. C **20**: 123–129. Mr 1942.

Schreiner, E. J. & Duffield, J. W. Metaxenia in an oak species cross. Jour. Hered. **33**: 97, 98. *f. 5*. Mr 1942.

Shull, J. M. Inheritance in daylilies. Herbertia **8**: 93–95. *pl. 210*. Ja 1942.

Smith, L. Hereditary susceptibility to x-ray injury in *Triticum monococcum*. Am. Jour. Bot. **29**: 189–191. *f. 1*. 10 Mr 1942.

Stout, A. B. Report on inter-specific hybridization in *Hemerocallis*. Herbertia **8**: 95–103. *pl. 211, 212*. Ja 1942.

Swanson, C. P. Meiotic coiling in *Tradescantia*. Bot. Gaz. **103**: 457–474. *f. 1–19*. 8 Ap 1942.

Thompson, W. P. & Hutcheson, I. Chromosome behaviour and fertility in diploid wheat with translocation complexes of four and six chromosomes. Canad. Jour. Res. C **20**: 267–281. pl. *1* + *f. 1–17*. Ap 1942.

Walker, R. I. Chromosome number of *Zanthoxylum americanum*. Bot. Gaz. **103**: 625–626. *f. 1–8*. 8 Ap 1942.

Walters, J. L. Distribution of structural hybrids in *Paeonia californica*. Am. Jour. Bot. **29**: 270–275. *f. 1–10*. 2 Ap 1942.

Whaley, W. G. & Whaley, C. Y. A developmental analysis of inherited leaf patterns in *Tropaeolum*. Am. Jour. Bot. **29**: 195–200. *f. 1–15*. 2 Ap 1942.

White, O. E. Genes, species, variability and plant-breeding. Am Nat. **76**: 191–207. Mr–Ap 1942.

PALEOBOTANY

Erickson, A. O. Brenner, L. G. & Wraight, J. Dolomitic glades of east-central Missouri. Ann. Mo. Bot. Gard. **29**: 89–101. *f. 1–5*. Ap 1942.

Hansen, H. P. The influence of volcanic eruptions upon post-Pleistocene forest succession in central Oregon. Am. Jour. Bot. **29**: 214–219. *f. 1*. 2 Ap 1942.

Hansen, H. P. A pollen study of lake sediments in the lower Willamette valley of Western Oregon. Bull. Torrey Club **69**: 262–280. 1 Ap 1942.

Hansen, H. P. Post-Mount Mazama forest succession on the east slope of the central Cascades of Oregon. Am. Midl. Nat. **27**: 523–534. Mr 1942.

Lenz, L. W. Contributions to our knowledge of American carboniferous floras: III. *Stipitopteris*. Ann. Mo. Bot. Gard. **29**: 59–68. *pl. 8–10*. Ap 1942.

Radforth, N. W. On the fructifications and new taxonomic position of *Dactylotheca parallela* Kidston. Canad. Jour. Res. C **20**: 186–193. *pl. 1*. Mr 1942.

Steere, W. C. Pleistocene mosses from the Aftonian interglacial deposits in Iowa. Papers Mich. Acad. **27**[1] (1941): 75–104. *pl. 1–5*. Mr 1942.

ECOLOGY AND PLANT GEOGRAPHY

(See also under Taxonomy: **Shreve**)

Allard, H. A. Destruction of *Pinus virginiana* in the Bull Run area by girdling. Va. Jour. **3**: 59. F–Mr 1942.

Brenner, L. G. The environmental variables of the Missouri Botanical Garden Wildflower Reservation at Gray Summit. Ann. Mo. Bot. Gard. **29**: 103–135. *f. 1–17*. Ap 1942.

Cleonique-Joseph, Frère. Étude sur les dunes et les champs de sable situés entre Lachute et Trois-Rivières Québec. Recherches Scient. Prov. Québec Contr. **2**: 1–94. *illust*. 1942.

Cronemiller, F. P. Chaparral. Madroño **6**: 199. 17 Ap 1942.

Epling, C. & Lewis, H. The centers of distribution of the chaparral and coastal sage associations. Am. Midl. Nat. **27**: 445–462. Mr 1942.

Howard, J. A. & Penfound, W. T. Vegetational studies in areas of sedimentation in the Bonnet Carré floodway. Bull. Torrey Club **69**: 281–289. *f. 1, 2*. 1 Ap 1942.

Olmsted, C. E. Growth and development in range grasses. II. Early development of *Bouteloua curtipendula* as affected by drought periods. Bot. Gaz. **103**: 531–542. 8 Ap 1942.

Oosting, H. J. & Billings, W. D. Factors effecting vegetational zonation on coastal dunes. Ecology **23**: 131–142. Ap 1942.

Scully, N. J. Root distribution and environment in a maple-oak forest. Bot. Gaz. **103**: 492–517. 8 Ap 1942.

Shreve, F. Grassland and related vegetation in northern Mexico. Madroño **6**: 190–198. *pl. 25*. 17 Ap 1942.

GENERAL BOTANY
(including biography)

Boivin, B. Quelques noms vernaculaires de plantes du Québec. Nat. Canad. **69**: 86–92. F–Mr 1942.

Castellanos, A. & Pérez-Moreau, R. A. Contribución a la bibliografia botánica Argentina, 1. Lilloa **7**: 1–549. 31 D 1941.

Chrysler, M. A. A botanist's summer in Costa Rica. Torreya **42**: 33–37. *f. 1*. 10 Ap 1942.

Dugand, A. On the vegetation and plant resources of Colombia. Chron. Bot. **7**: 71–75. Mr 1942.

Fernald, M. L. Incidents of field-work with J. Franklin Collins. Rhodora **44**: 98–147. *pl. 696–707*. Ap 1942.

Fosberg, F. R. Uses of Hawaiian ferns. Am. Fern Jour. **32**: 15–23. Ja–Mr 1942.

Harper, R. M. Natural resources of the Tennessee Valley region in Alabama. Geol. Survey Alabama Spec. Rept. 17: 1–93. Mr 1942.

Marie-Victorin, Frère. Histoire de l'Institut Botanique de l'Université de Montréal 1920–1940. Contr. Inst. Bot. Montreal 40: 1–70. *f. 1–22*. 1941.

Neal, D. C. Lee Ellis Miles. Phytopathology **32**: 267–270. *port*. Ap 1942.

Reid, H. S. A short history of the plant sciences. 1–320. *f. 1–37*. Chronica Botanica Co., Waltham, Mass. 1942.

[Rickett, H. W.] Robert Almer Harper. Bull. Torrey Club **69**: 331. *port*. 1 My 1942.

St. John, H. Bibliographic note upon Gray's Revision of North American *Oxyropis* and *Saxifraga*. Rhodora **44**: 90, 91. 7 Mr 1942.

Schubert, B. G. Willdenow's Species Plantarum and Michaux's Flora Boreali-Americana: Dates of publication. Rhodora **44**: 147–150. Ap 1942.

Smith, H. M. The publication dates of "La Naturaleza." Lloydia **5**: 95, 96. Mr 1942.

Snell, W. H. J. Franklin Collins. Rhodora **44**: 93–97. *port*. Ap 1942.

Williams, L. Natural resources of Venezuela. Chron. Bot. **7**: 75–77. Mr 1942.